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# Hand-Book of Common Water and Marsh Plants of India and Burma, 1936

By

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AND

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## AUTHORS' PREFACE.

The origin of this work lay in an appreciation of certain difficulties in their field work that confronted officers associated with the Malaria Survey of India. The utility of a bulletin confined to the water and marsh vegetation of India was first raised by Mr. R. Senior White, F.R.S.E., Malariologist of the Bengal Nagpur Railway, Calcutta. Officers whose duties lead them to a study of the distribution and life history of the parasite carrying mosquitoes frequently complained of the absence of any handy work confining itself to the vegetation of tanks, ponds, jheels, etc., and it was suggested that a study of larvæ themselves could not be complete without some knowledge of the plant associations, etc., in which they bred. An early attempt to arrange and describe the commoner water plants of the district soon led to the realisation that if a publication was to be of any use, it had to comprise a greater number of plants than we had originally estimated would be necessary. Thus the disadvantages of eliminating the Cryptogams from a work on water vegetation become evident, for it is largely in association with the Cryptogams that mosquito larvæ breed. The necessity of adding the commoner and especially the gregarious algæ needed no excuse but it delayed the completion of this bulletin.

Even now it has been found difficult to incorporate all the higher plants that might be of interest. We have, so far as possible and in view of the limited knowledge of botany of the officers who will handle this book, tried to avoid technical terms and the keys have been arranged in such a manner that the principal distinguishing characters come first to notice. They cannot, however, be read by themselves and it will in most cases be necessary to refer to the description of species given as well as to the figures. Descriptions and figures of a number of the commoner algæ, chiefly those which grow gregariously and sometimes cover tanks in dense floating masses and serve either as food or shelter to larvæ, have been added with notes on the

periodicity. There has also been added a short glossary of botanical terms, reference to which will explain the meaning to any collector unacquainted with the terms used.

The cost of production of plates was borne by the Indian Research Fund Association.

HERBARIUM,
ROYAL BOTANIC GARDEN,
CALCUTTA:

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## CONTENTS.

# GLOSSARY.

## A

Abortion—imperfect development or non-development of an organ.

Accrescent—increasing in size with age usually said of parts of the calyx or corolla that persist and enlarge after flowering

Achene—a small dry indehiscent 1-celled 1 seeded point or a 1 seeded indehiscent carpel of an apocarpous fruit

Acicular—needle shaped

Actinomorphic—divisible into similar halves by two or more planes

Aculeate—prickly, beset with aculei

Acuminate—long pointed, tapering to a point

Acute—evenly tapering and ending in a narrow angle but without a prolongation

Adherent—touching closely or broadly

Adnate—said of dissimilar organs when congenitally united touching closely or broadly

Adpressed—lying close throughout the entire length against the surface

Agglomerate }—heaped or crowded into a dense cluster, but not cohering
Aggregate }

Albumen—the nutritive substance found within the seed coats of some seeds outside the embryo

Amoeboid—resembling an amoeba

Amorphous—without definite form

Amplexicaul—said of a sessile leaf or the base of a petiole when clasping the stem

Anatropous—said of an (inverted) ovule i e one with the micropyle close to the hilum and the calaza, at the opposite end the axis of the ovule itself remaining straight

Androspore—a special kind of zoospores produced in cells which originate the dwarf males in Oedogonium

Angular—having corner

Annual—plant lasting a year.

Annular—ring shaped

Annulate—marked with rings

Anther—the part of a stamen that bears the pollen

Antheridia—certain productive organs supposed to be analogous to anthers or fecundative

Apex—top of a leaf or flower

Apical—relating to the apex or tip

Apiculate—with a short pointed tip

Appressed—lying flat against or together for the whole length

Arcuate—bent like a bow

Areola—an angular space with an elevated margin

Articulate—composed of joints

Aril Arillus—an accessory seed-covering or an appendage growing from or about the hilum of a seed

Asexual—without sex

Axile—relating to the axis

Axillary—growing in an axil (the angle between stem and leaf)

Azygospore—spore produced without copulation

## B

Beak—a sharp tip like the bill of a bird

Berry—a simple fruit succulent throughout without a stone and generally with more than one seed

Biconvex—double convex.
Bicornate—two horned.
Bifid—divided into two segments with a narrow sinus; two cleft.
Bilabiate—having two lips, a term usually applied to gamosepalous calyces and gamopetalous corollas.
Bilobed—divided into two lobes.
Binate—in pairs.
Bipinnate—twice pinnate.
Bisexual—having both stamens and pistil in the same flower (hermaphrodite).
Bivalved—two valved (flats or door).
Blade—blade of a leaf; the extended portion of a leaf or petal.
Botryoid—in clusters, like a bunch of grapes.
Bract—a rudimentary or modified leaf subtending a flower or an inflorescence.
Bracteole—a small bract.
Brackish—somewhat salty.
Bulb—a spout, usually underground stem, consisting of a short axis, bearing a bud or buds enclosed in fleshy scales or coats.

## C

Caducous—falling off very early.
Caespitose—growing in tufts, with many stems from one root.
Caeruleus—sky blue or pure blue.
Calyptra—cap or lid.
Calyx—the outer whorl of floral leaves.
Campanulate—bell-shaped deeper than cupshaped.
Capillary—slender, hairy or thread like.
Capitate—having a globose head.
Capitulum—a globose head or shortly pedicellate flowers.
Capsule—a dry syncarpous fruit which opens at maturity to discharge the seed.
Carpel—one of the component parts of a syncarpous or apocarpous pistil.
Carpospore—spores produced (by conjugation) in a sporocarpium.
Cauline—pertaining to the stem.
Cell—the structural unit in the formation of a plant; one of the cavities of an ovary or of an anther.
Cellulose—the material, chemically considered, of which the wall of the cell consists.
Chlorophyl—the green colouring matter of leaves and of green algæ.
Chlorophylose—resembling chlorophyl-green.
Ciliate—having cilia; furnished with hairs.
Circinate—curled round, coiled or spirally rolled up.
Clavate—club-shaped.
Claw—the narrowed base of certain petals.
Coenobium—a community of a definite number of individuals united in one body.
Coma—a tuft of soft hairs or cotton borne on seed.
Comose—having a coma.
Compressed—pressed together.
Concave—hollow.
Conidium—gonidium.
Connate—organs or parts of the same organ when congenitally united.
Contorted—twisted in one direction upon itself.
Cordate—heart shaped.
Coriaceous—leathery, tough and thick.
Corniculate—furnished with a little horn.
Corolla—the inner whorl of floral leaves.
Crenate—with rounded teeth.

Crustaceous—hard and brittle or forming a crust
Cuneate—wedge shaped acute angle at the base
Cuspidate—tapering gradually to a sharp stiff point
Cyme—an inflorescence of the definite or centrifugal type in which the main axis and all the lateral axis are each terminated by a flower so that the flowering proceeds from the centre outward
Cylindrical—elongated and with circular cross section, in the form of a cylinder
Cypsela—a dry inferior achene invested with the adnate calyx

## D

Deciduous—trees or shrubs which are leafless for a part of the year
Decumbent—inclined downwards
Decurrent—produced down as a sessile leaf when the blade is prolonged below the insertion along the stem forming a winged appendage
Deflexed—bent downwards
Dehiscent—the mode of opening of a capsule or of an anther
Deliquescent—dissolving
Dentate—with margins cut into triangular salient teeth directed outward
Denticulate—minutely toothed, having denticulation or diminutive teeth
Diadelphous—stamens united by their filaments into two sets of bundles
Dichotomous—forked equally
Diœcious—when the male organs are borne on one plant and the female on another
Didynamous—flower with two long and two short stamens and also of stamens when they are such
Diffuse—widely spreading
Disciform—depressed and circular like a disc or point
Disc or Disk—an enlargement of the receptacle of a flower in the form of a cup or cushion ring or glands
Divaricate—spreading widely apart
Dorsal—relating to or inserted on the back
Drupe—a stone fruit, i e one with a fleshy or pulpy pericarp and bony or crustaceous endocarp

## E

Ellipsoid—a solid with an elliptical outline
Elliptic—oblong with rounded end
Elongate—extended
Emarginate—with a notch at the apex
Embryo—the rudimentary plantlet formed in a seed
Endospore—the inner coating of a spore
Epigynous—growing on the pistil apparently above the ovary
Epiphytal—growing upon plants
Epizoic—growing upon animals
Exalbuminous—without albumen
Exerted—projecting outwards as anthers beyond the corolla
Exosporium—the outer membrane on the coat of a spore
Extipulate—without stipulate
Extrorse—applied to anthers that dehisce outwards i e away from the axis of the flower

## F

Falcate—scythe shaped or sickle shaped
Family—a group of co related genera
Fascicled—in dense clusters

## GLOSSARY.

Fasciculate—in little bundles from a common point.

Fastigiate—said of branches when parallel, clustered and erect.

Ferruginous—coloured to immitate iron-rust.

Filament—the stalk of an anther.

Filiform—thread like.

Fimbricate or fimbriate—having a fringe or border of fine thread like process.

Foliaceous—of the form or texture of a leaf.

Flagelliform—like a whip lash.

Floccose—bearing or clothed with locks of soft hairs or wool.

Follicle—a dry fruit, resulting from a single carpel opening by only one usually the inner structure.

Fulvous—tawny; orange yellow and gray mixed.

Furcate—forked.

### G

Gamosepalous—having combined sepals.

Gelatinous—jelly-like.

Genus—group of closely related species indicated by the first name of a plant.

Geminate—twin; in pairs; two side by side.

Geniculate—bent abruptly; like a knee.

Glabrescent—becoming glabrous.

Glabrous—without hair of any kind.

Glandular—having glands or relating to glands.

Glaucous—a bushy grey colour, often covered with a fine bloom.

Globose—nearly spherical.

Gonidia—propagative bodies of small size, not produced directly or by any act of fertilization.

Granular—composed of grains or divided into small knots or tubercles.

Gynandrosporous—bearing male and female spores.

### H

Hastate—spear shaped.

Herbaceous—herb-like with succulent stem.

Hermaphrodite—bisexual, having both stamen and pistil in the same flower.

Heterocyst—intercalated cells of a special character differing from their neighbours.

Heterogamous—flower heads when male, female, bisexual and neuter florets or any two or three of those, are borne on the same head.

Hilum—the place of attachment of an ovule or seed to the placenta or funicle.

Hirsute—thickly covered with long and coarse hair.

Homogeneous—of the same kind, all of one nature or kind.

Host—a plant which supports a parasite (an epiphyte).

Hyaline—transparent or translucent and colourless.

Hypnospore—resting spore; spores which repose sometime before germinating.

Hypogynous—inserted below the ovary.

### I

Imbricate—overlapping.

Incise—cut sharply and regularly.

Indehiscent—fruit—the pericarp of which does not open to discharge the seeds.

Inflorescence—the mode in which the flowers are arranged on the stem.

Insectivorous—insect eating.

Interstital—placed between.

Introrse—anthers that are twined and open towards the axis of the flowers
Involucre—a circle of bracts subtending a flower cluster
Involute—rolled inward

## K

Keel—the central dorsal ridge, like the prow of a boat formed by the two anterior and innermost petals of a papilionaceous corolla
Kernel—the inner part of a seed containing the embryo

## L

Lacerate—irregularly cleft as if torn or lacerated
Lacuna—a depression cavity or inter-cellular space
Laevis—smooth not rough
Lamellæ—thin plates or membranes parallel to each other
Lamina—the blade of a leaf
Lanceolate—shaped like a lance head
Legume—a fruit of a single carpel usually opening by both sutures when ripe
Lenticular—lens-shaped
Ligule—anything shaped like a strap
Ligulate—strap-shaped usually applied to the ray florets of Compositæ
Linear—narrower than lanceolate
Lip—one of the two divisions of a bilabiate calyx or corolla
Lobe—any division of an organ or specially a rounded division or projection
Lobulate—divided into small lobes
Loculicidal—a kind of dehiscence of a capsular fruit in which splitting takes place
Lunate—crescent shaped

## M

Macrandrous—having elongated male plants
Mammillate—bearing shaped processes
Membranous—thin pliable like a membrane
Mobile—movable
Monodelphous—stamens united by their filaments into one bundle forming a tube or column
Moniliform—necklace shaped contracted at regular intervals
Monœcious—unisexual with the male and female flowers on the same plant with male and female organs on the same plant
Mucro—a short and abrupt small tip
Mucronate—abruptly terminating in a sharp point
Multifid—cleft into many lobes or segments

## N

Nanandrous—having short or dwarf male plant
Nerves—the principal lateral ribs of a leaf
Nucellus—the central part of an ovule containing the embryo sac
Nut—a hard indehiscent one seeded fruit

## O

Obconical—inversely conical
Obcordate—inversely cordate
Oblique—one half larger than the other unequal

Oblong—much longer than broad.

Obovate—inversely ovate.

Obovoid—a solid which is inversely egg-shaped in outline.

Obtuse—blunt at the apex.

Ochraceous—ochre colour; light yellow with a tint of brown.

Ochrea—a membranous tabular stipule, forming a sheath round the stem.

Oogonia—an ovarian sac or cell bearing oospores.

Oospore—spores produced in an ovarian sac.

Operculum—a lid.

Opposite—set in pairs, in opposite side of a stem.

Orbicular—flat with the outline circular or nearly so.

Ovary—that portion of the pistil which includes one or more cavities or cells containing one or more ovules.

Ovoid—egg-shaped.

Ovate—egg-shaped in outline with the broad end towards the base; of the shape of the longitudinal section of hen's egg.

Ovule—the embryonic seed in the ovary.

## P

Panicle—a compound inflorescence in which the main axis is racemose and the secondaty and tertiary ramifications are racemose or not.

Papilionaceous—butterfly like.

Pappus—the hairy tuft on the fruit on the Compositæ and similar dry indehiscent fruit.

Parasitic—growing on or in and living upon another plant or animal.

Parthenogenesis—production of fertile seed without sexual impregnation.

Pectinate—pinnatifid, with narrow close segments, like the teeth of a comb.

Pedicel—the ultimate stock supporting a single flower in an inflorescence.

Pedicellate—having a foot or stem.

Peduncle—the stock supporting a solitary flower or fruit or a cluster of flowers or fruits.

Peltate—shield shaped.

Pentamerous—having the members in each whorl of the flower in fives.

Perianth—a floral envelop.

Pericarp—the portion of the fruit formed of the walls of the ovary and whatever adheres to it inclusive of and outside the seed.

Persistent—remaining attached.

Petal—one of the division of the corolla.

Petiole—the stalk of a leaf.

Piliferous—bearing hairs, hairy.

Pilose—hairy.

Pinnae—the primary division of a bipinnate or tripinnate leaf.

Pinnate—a compound leaf is so called when the leaflets are arranged on either side of a common axis.

Pinnatifid—deeply pinnately lobed to about half way down.

Pistil—the female organ of a flower consisting normally of ovary, style and stigma.

Pistillode—a rudimentary or barren pistil.

Placenta—that portion of the interior of an ovary on which the ovules are borne.

Plumose—feathered branched on either side like the plume or wages on the shaft of a feather.

Pod—a dry dehiscent many seeded fruit.

Pollen—a minute powder like grain contained in the anther cell.

Posterior—that part of a flower which is nearest to the axis of inflorescence.

Prothallus—the false thallus first formed on germination of a spore.

Pseudo-branches—false branches, or resembling branches.

Pubescent—covered with short, soft, straight hairs.

Pulvinate—cushion-shaped.

Punctate—dotted with small punctures or glands
Pungent—tapering gradually to a hard sharp point
*Pyriform—pearshaped*

## Q

Quadrangular—four cornered
Quadrate—square
Quinquefoliate—with five leaflets

## R

Raceme—an inflorescence of the indefinite kind in which the flowers are borne on pedicels or more or less the same length along a single undivided axis or rachis Flowers growing towards the centre (centripetal)
Rachis—the principal axis of a pinnate leaf or of an inflorescence
Ramulus—a small or secondary branch
Radical—the axis of an embryo below the cotyledons
Ray—one of the radiating branches of an umbel
Receptacle—the torus of a flower
Recurved—curved backward or downward
Reflexed—bent abruptly backward or downward
Regular—symmetrical generally the petals or perianth segments alike in size and shape
Reniform—kidney shaped
Replicate—folded back
Resting spore—a spore which becomes quiescent or rests for a time more or less long before germinating
Reticulate—having the veins connected together like the meshes of a net
Rhizoid / Rhizome—Resembling or analogous to a root an underground or prostrate stem of root like appearance with an apical growing point which sends off roots at the nodes and bears like a true stem buds leaves or scales
Rhomboid—with four sides more or less and the lateral angles obtuse
Rostrate—terminating with a beak
Rugose—full of wrinkles

## S

Saccate—sac shaped, baggy
Sagittate—shaped like an arrow head
Scalariform—barred or crossed like the rounds of a ladder
Scabrous—very rough to the touch owing to short stiff hairs
Scrobiculate—marked with little pits or depressions
Scape—a leafless and generally unbranched flowering stem rising from the ground
Scarious—thin dry membranous somewhat stiff and not green
Secund—when parts or organs are all directed to one side
Sepal—one of the segments of the calyx especially when not combined
Septicidal—a form of dehiscence of a ripe carpel when it opens through lines of junction of the carpels
Septum—Partition or division
Seriate—in rows traverse or lengthwise
Serrate—toothed like a saw
Serrulate—minutely serrate
Sessile—without a stalk
Seta—a bristle or bristleshaped body
Sheath—a closely fitting tubular or enrolled case
Shrub—a woody plant of small size
Sigmoid—shaped like the letter S,
Simple—undivided

Sinuate—with an irregular deeply wavy margin.

Sinus—a depression or notch.

Spathulate—shaped like a spathula; spoon-shaped.

Spermatozoa, Spermatozoids—thread like bodies possessed of motion, supposed to have fecundative power.

Spike—a racemose inflorescence bearing sessile flowers on an undivided axis.

Spermogoia—cells which give rise to the spermatozoids.

Spikelet—a secondary spike.

Spinose—furnished with *spines or of a spiny* character.

Sporangium—a spore case having spores produced within it.

Stamen—a male organ of a flower, consisting of a filament and an anther.

Staminode—an abortive or antherless stamen.

Stellate—star-shaped.

Sterile—barren; destitute of fruit or fruit bearing cells.

Stigma—that part of the pistil which is specially adopted for the reception of the pollen for the fertilization of the ovule.

Stipule—an appendage of a leaf, usually one on either side of the petiole.

Stone—the hard endocarp of a drupe.

Striate—marked with longitudinal lines or minute furrows.

Style—a stalk-like outgrowth from the summit of the ovary supporting the stigma.

Subulate—shaped like a cobbler's awl, narrow, tapering and somewhat stiff; awl shaped.

Succulent—with abundant cellular tissue full of juice.

Syngenesious—stamens united by their anther as in Compositæ.

## T

Tap-root—primary root resulting from the direct prolongation of the radicle.

Tegument—a covering or membrane.

Tendril—a slender process usually belonging to the axis as serving as a support in climbing.

Terete—cylindrical, rounded in cross section.

Ternate—arranged in threes in a cluster or whorl.

Testa—the outermost coat of a seed; the hard outer covering of a seed.

Thallus—a stratum, in place of stem and foliage.

Thalamus—that part of the axis of a flower which supports the floral whorls and the pistil.

Tissue—an aggregation of cells differenciated from surrounding aggregation.

Tomentose—covered with short, soft, rather dense more or less tangled hairs.

Torulose—almost synonymous with moniliform.

Torus—same as thalamus.

Trichome—the thread or filament of filamentus algæ.

Trichotomous—dividing in threes.

Truncate—as if cut off at the end.

Tuber—a thickened modification of underground stem bearing buds or eyes.

Tuberculate—covered with wart like projections or excrescence.

Turgid—swollen and more or less firm.

Turions—winter bud which pass a dormant period *in unfavourable conditions* and renewing its growth during favourable conditions.

## U

Undulate—wavy.

Unicellular—literally composed of one cell.

## V

Vacuole—a small clear space drop like seen in the interior of the protoplasm of a cell
Vagina—a sheath sheathing
Valvate—with the margins of the members of a whorl only meeting without overlapping
Variety—a sort of modification subordinate to species
Verrucose—irregularly swollen at intervals
Versicolar—changing colour or of more than one tint or colour
Ventral—lower surface of flattened ribbon like thalli
Verticillate—arranged in whorls
Vesicle—a small bladder or air cavity
Villose—more or less thickly covered with long soft simple hairs

## W

Whorl—a collective name for all similar members that are arranged in a circle, round an axis
Whorled—disposed in whorls
Wing—any thin membranous appendages

## Z

Zoosporangium—sporangium enclosing zoospores
Zoospores—locomotive spores
Zygomorphic—capable of being bisected into similar halves by a median plane only
Zygospore—a spore resulting from conjugation

# HAND-BOOK

OF

# Common Water and Marsh Plants of India and Burma.

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## BIONOMICS OF FRESHWATER AQUATIC VEGETATION.

Growth of vegetation occurs in 'Surface Water' 'Surface water' includes waterfalls ...

## ERRATA.

### BIONOMICS OF FRESH WATER AQUATIC VEGETATION.

Page 3 —Last line of paragraph 2 should read 'Bengal in particular and of India in general'

Page 4, line 18 —Reference is needed in brackets after 'floating zone' The reference is 3

... The biological conditions thus set up by plant and animal denizens are in their turn interdependent *on the other factors noted above* *Lakes jheels tanks ponds etc* each forms a closed community of its own Each of them has a stock of plant and animal life living under certain similar conditions Thus plant and animal associations by their mutual co operation produce seasonal and diurnal changes in the cycle of distribution of dissolved gases which again in its turn plays an important role in the development and sustenance of Flora and Fauna of a water reservoir Owing to higher temperatures not only is growth of organisms in tropical waters more rapid but decay is more sudden Due to the speed of evaporation and the heavy rainfall conditions of India water areas are altered as much in a few hours as it would take days to do in temperate climates Moreover the rapid changes in temperature have their effect In the zone of stagnation vegetable matter decomposes rapidly putrefying bacteria being present to a large extent All these factors lead to the rapid exhaustion of oxygen in our tanks and to a production of gases harmful to living organisms

It has been observed that the oxygen content of the bottom water is less than that of the surface water. During hot months in April to May towards the morning oxygen is nearly absent, whereas the carbon-dioxide content is much increased. At night when the process of carbon assimilation is absent, a water sheet, so thickly covered with surface vegetation as to prevent the absorption of atmospheric oxygen, becomes exhausted of its oxygen content. The exhaustion is accelerated by the organisms using up the oxygen present. Conditions may reach a stage, when the water becomes so fetid by the presence of gases, that animal organisms, including fishes, may die. In such conditions the presence in large quantities of Myxosporidia and decomposed algæ has been detected. These are supposed to choke up the gills and infest other internal organs and are the immediate causes of fish mortality, the ultimate cause of which is the condition of the tank. Instances of such fish mortality causing considerable financial loss are common in this country in warm season. On a hot day frequently towards the morning after a shower of rain overnight fishes are sometimes found floating near the margin stupefied and gasping for fresh air. The reverse process of purification of tank water is soon brought about through the open surfaces where oxygen diffuses. It is also helped by the presence of organisms which live on decomposing matter and by the photo-synthesis of the living algæ. Naturally any means whereby a tank is agitated whether by wind or by man aid solution of oxygen.

The first to get hold of the impurities are putrefaction bacteria, the action of which results in the production of Ammonia, Acetic Acid, Humic acid, Sulphuretted Hydrogen, Methane, Carbon Monoxide, Peptone and various other organic compounds of a complicated structure. These compounds are assimilated by plankton algæ and other members of the plant kingdom. As soon as these have consumed the obnoxious substances they are swallowed up by small members of the animal kingdom which in their turn serve as food to larger Crustaceans, mosquito larvæ and fishes. The latter animals—particularly mosquito larvæ—as examination of their gut contents reveals, utilise plankton algæ which are by no means their unimportant food materials. Sometimes filamentous algæ such as *Oscillatoria tenuis, O. Aghardii, O. princeps, Lungbya confervoides. Oedogonium sp., Spirogyra nitida, S. maxima, Hydrodictyon reticulatum, Tribonema bombycinum, Chaetomorpha Linum, Pithophora oedogonia* and *Cladophorao crispata* form the harbouring and foraging ground of larvæ. These algæ mixed with a few other species sometimes float in huge masses on the surface of water forming what is generally called *Trichoplankton,* (Photo III). It may, however, happen that ponds, tanks, jheels, etc., are so overloaded with refuse matters that sometimes the sanitary agents maintaining the self-purificatory action of the water are unable to fulfil their obligations. In consequence of this state of things Sulphur bacteria *(Biggiotoa)*, Iron bacteria, (*Leptothrix ochracea. Siderocapsa Traubi*), *Spirulina major, Chlorella vulgaris, Arcella, Euglena, sp.* and certain *Infusoria* gain the upper hand. Some of these occur so constantly in contaminated waters that they can be used as indicators of an insanitary state of the water. Mosquito larvæ are abundant in such insanitary stagnant water often sheltering under the floating masses of vegetation. The occurrence of

mosquito larvæ in large numbers has even been observed in the open filter beds of water system in different parts of the country. [1]In such filter beds the luxuriant development of microphytoplankton and one or several species of filamentous algæ mentioned above is noticed within the course of a few days These algæ grow at first on the bottom But finally due to pressure exerted by gases caught up in their interstices they are gradually raised on the surface and float Thus floating they harbour mosquito larvæ supplying them food and accommodation The disturbance of the algæ from the bottom purifying vital layer leaves this layer perforated and less able to perform its purifying function

Limnological investigation and study of bionomics of Indian waters are in its infancy Observations of Annandale, Bruhl, Biswas and Pruthi, offer some clue to the relation of plant and animal organisms in relation to their environments Pruthi records, during his investigation of the Indian Museum tanks (which may be considered as a type of Indian tanks) that " Temperature of surface water is lowest in January being 22 5° C With the rise in air temperature the water temperature also rises and reaches its maximum about the end of April or the first half of May when it is 34 5-34 7° C at 12 noon With the onset of the monsoons in the first half of June the temperature falls by one or two degrees and then remains almost constant up to the middle of October It then starts falling rapidly reaching the minimum in January " " The Hydrogen-ion concentration, alkali reserve and carbon dioxide content are interdependent The pH value has two maxima in the year a vernal and an autumnal, the latter being higher than the former The range of pH value of the surface water is 7 4 to 9 0 The pH value of the bottom water shows very slight seasonal changes It ranges 7 45 to 7 65 It is always lower than that of the surface water The changes in the pH value of the water seem to be connected with the photosynthetic activity of the Chlorophyll bearing organisms which is dependent on the condition of weather and on the amount of necessary salts available " Preliminary observation of the writers tallies in general with Pruthi's conclusion regarding bionomics of many of the tanks of Bengal in particular and India in general

## *GENERAL FEATURES OF AQUATIC VEGETATION.*

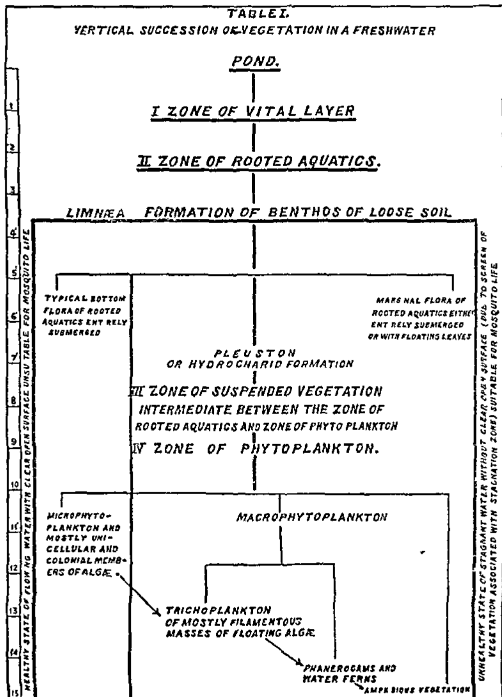
A pond, a tank or a jheel has well defined limits within which the life history of particular types of Flora and Fauna can be studied under all climatic conditions and during all seasons Certain plants are observed to flourish on moist swampy ground and along the margin of water and some plants under certain conditions spread over the surface of water Others are suspended in the water Some are rooted to the bottom of the pond and are entirely submerged Then again there are others which have floating leaves and flower above the surface of the water In addition to these there are also a number of minute plants many of which are microscopic, which float freely in water and thus pass a free unattached existence Details of all these plants are not within the scope of the present work We propose to draw the attention of our readers only to some of the commoner plants occurring in these different zones of aquatic media in this country.

In ponds, tanks and jheels, etc., which are more or less permanent and are not subject to rapid drying up, four zones of aquatic vegetation may be distinguished. The bottom zone of vegetation occurs on the clay or silt which being more or less impermeable sustains species of microscopic organisms such as Sulphur bacteria, schizomycetes, flagellata, blue-green algæ and Diatoms which constitute the "vital layer". Some of the organisms in this layer as discussed in previous pages are active agents in decomposing the vegetable and animal matter settling and in producing the chemical changes necessary for other growths. Rooted aquatics completely submerged, chiefly composed of higher phanerogams, form the second zone. *Vallisneria spiralis* forming frequently a pure association is the most common species met with in this zone. The third zone consisting frequently of *Hydrilla verticillata, Ceratophyllum demersum, Najas foveolata, Utricularia stellata* and *Lagarosiphon Roxburghii* and others is unattached free floating—yet submerged. This submerged floating vegetation is collectively known as *Pleuston* (Photo V). Under conditions in which the surface of the water becomes choked the free floating zone ( ) of vegetation may further disturb the normal purifying action going on. Lastly, there is the zone of surface vegetation called Microphyto or Macrophyto plankton according to whether it consists of minute microscopic plant organisms or higher aquatic plants.

The former is chiefly composed of plankton algæ and the latter of several species of higher plants forming pure or mixed associations. Of some of the most common plankton algæ—*Clathrocystys aeruginosa, Chlorella vulgaris, Euglena sp.*, Zoospores of various green algæ, *Arthospira platensis, Anabaena flosaquæ, Volvox glabator, Cosmerium sp.* and *Diatom sp.* may be mentioned. Of Macrophytoplankton *Eichornia speciosa, Pistia stratiotes, Salvinia cucullata, Ceratoptris thalictroides, Lemna sp., Azolla pinnata, Wolffia arrhiza* are abundant in ponds, tanks, etc. (Photos I, II and V). The above classification of zones may be employed irrespective of the marginal vegetation. In the marginal association of plants we find commonly members of *Limnanthemum, Potamogeton, Aponogeton, Trapa, Nymphæa, Nelumbium, Chara* and *Nitella*. These hydrophytes are designated "Limnæa formation of Benthos of loose soil". Although species like *Nymphæa* and *Nelumbium* the water lilies, are frequently found covering the whole surface of water area they belong in reality to the marginal vegetation for they must always be rooted and it is only in conditions of relatively shallow water that is in marginal conditions that they survive best. Such lotus tanks in full bloom present a charming spectacle, although, they might offer favourable grounds for breeding of mosquitoes (Photo IV). Other plants mostly of marshes sometimes extending across the choked up surface of ponds increase the bulk of the surface screen of vegetation (Photos I, II and V). Such plants may be termed amphibious plants, *i.e.*, they are capable of growing on moist lands as also of floating on water. *Jussiæa repens, Enhydra fluctuans, Colocasia antiquorum, Marsilia quadrifoliata, Ipomœa reptans, Oenanthe bengalensis, Herpestis Monnieria, Leersia hexandra, Hygrorhiza arista, Orizza sativa* (wild rice), *Polygonum orientale, Neptunia oleracea* are some of the common plants which are of amphibious habit. When all the above

zonal conditions are present, the tank is almost certain to be in good state for the development of mosquito larvæ The water is stagnant, protection from light is present and food for the larvæ is plentiful Moreover, larvae in such conditions are normally better protected from their higher enemies.

The following table represents the succession of vegetation in a tank. Successions of water in general sketched in Table I and illustrated in the following diagrammatic representation



We have so far discussed the nature mostly of a stagnant pond in which the vegetation in different zones played its role and brought about an insanitary state of water by cutting off sufficient light rays and resulting in the depletion of oxygen.

The opposite set of conditions of aquatic vegetation may now be discussed. See, diagrammatic representation showing two kinds of tanks. The primary condition for this is a clear open surface. Suspended vegetation should be absent and the amount of rooted submerged vegetation should be proportionate to the area of the tank. The self-purifying action of water consists in a balancing of the various useful faunal and floral action in an expanse of water. But its existence is not necessarily deleterious. If the tank is free from surface vegetation and allows light to penetrate the sun performs the normal useful oxygenating action which in turn helps the growth of the purifying microphytoplankton. From observation of Indian freshwater vegetation, one is led to support Pond's formula for the development of microphytoplankton. It runs as follows: "The amount of plankton produced by bodies of freshwater is, other things being equal, in some inverse ratio proportional to the amount of its gross non-rooted vegetation and in some direct ratio proportional to the amount of its gross rooted vegetation".

The microphytoplankton is at once a purifying agent and is the chief source of food to the smaller aquatic animals. These are again devoured by larger fishes which finally form an important diet for human beings. Such mutual relation of plant and animal life of Indian waters is exhibited in Table II.

## TABLE II.

DECOMPOSED PLANT AND ANIMAL REMAINS (AT THE BOTTOM).

Putrefaction bacteria, Schozomycetes, Blue-green algæ, Flagellates, etc.,

Phyto-plankton

(absorbing obnoxious gases and maintaining balance of super-saturation).

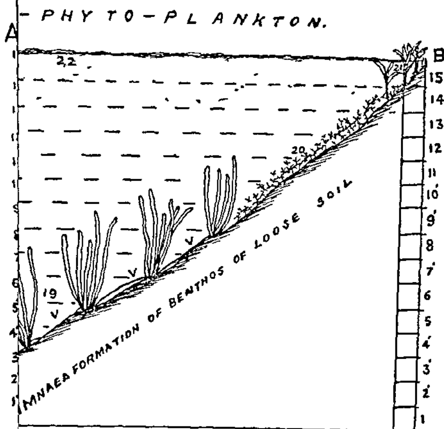
Zoo-plankton

(living on phyto-plankton).

Fairly large animals (mosquito larvae, smaller crustacea).

Fishes.

Human Beings.




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cleaning tanks.—The addition of chemicals may have a certain temporary effect but they are likely to be costly and their effects fleeting Deepening of tanks when this can be economically done especially in the neighbourhood of human habitations would probably be the best method of maintaining both the tank and the neighbourhood in healthy condition Whether this is not possible on account of the extent of the tanks, it

might yet pay to confine attention to the sides where it is found that the presence of vegetation allowing for the feeding and protection of larvæ has an effect on the breeding of mosquitoes. It is true that steep tanks are less favourable to mosquito larvæ than sloping banks especially at times when the water tends to dry up for in the latter case puddles tend to be left and it is here better than in the tanks themselves that the mosquitoes tend to lay eggs.

Where tanks can be agitated by a diversion of water to allow some degree of constant movement the diversion should be made. Such conditions at the same time favour the existence of those higher animals that feed on larvæ.

Much can no doubt be done by a study of the vegetation of a tank by maintaining the plant life in it in a normal healthy condition.

## SYSTEMATIC ENUMERATION OF SPECIES.

### Family—RANUNCULACEÆ.

Annual or perennial herbs or shrubs. Leaves radical or alternate, rarely opposite. Flowers regular or irregular, hermaphrodite or unisexual. Sepals 5 or more, rarely 2-4, often deciduous, petaloid, imbricate, rarely valvate. Petals absent or 5 or more, rarely 3, often minute or deformed. Stamens many, hypogynous; anthers usually adnate, dehiscing laterally. Fruit generally of many one seeded achenes or follicles.

### Genus—RANUNCULUS.

Annual or perennial herbs. Leaves alternate, lobed or dissected. Stipules membranous or absent. Flowers usually panicled white or yellow. Sepals 3-5, caducous, imbricate in bud. Petals usually 5 or absent, often glandular near the base. Stamens many. Carpels many; style short; ovule 1, ascending. Fruit a head or spikelet of beaked or apiculate achenes.

#### RANUNCULUS SCELERATUS Linn. (Pl. IX, Fig. 1.)

An erect, annual, glabrous herb of marshes or moist shady places. Root fibrous. Stem erect 1-3 ft. fleshy, branched above smooth, piped. Leaves below petioled, three-parted and ternate with cuneate cut segments, cauline, sessile, with leaflets linear lanceolate, all are smooth on both the surfaces. Stipules membranous. Flowers many, terminal, and from the divisions of the branchlets forming nearly an umbel, small, yellow. Calyx spreading, five lobed. Sepals reflexed, nearly as long as the petals, a little woolly outwardly. Petals 5, oblong with a honey bearing pore within the claw. Nectaries about 20. Stamens 20. Receptacle oblong hairy. Achenes many in an oblong head, small, obtuse or apiculate. Seeds smooth, sessile on a cylindric receptacle, oval, laterally compressed with a pointed top.

*Hab.* Common as an acrid weed in the banks of rivers and nullahs and in shady moist marshy areas of Bengal and Northern India, also found in the marshes of Peshawar and warm valleys of the Himalayas.

## Family—NYMPHAECEÆ

Perennial water plants rooted in the mud Stem rhizome developing runners for vegetative reproduction Leaves radical with the lamina floating on the surface of water, borne on long petioles, lamina cordate or peltate, involute in bud Scapes naked unbranched, bearing at the apices of long pedicels solitary flowers Flowers with all the floral whorls free, hypogynous, perigynous or rarely epigynous Perianth all free, spirally imbricate, sometimes indistinguishable Sepals gradually transforming into petals and petals to stamens, but when distinct sepals 3-5 or more Stamens many Carpels 3 or more either free or connate or irregularly scattered or sunk in pits of the fleshy disc Fruit a many celled berry like Seeds naked or with an arillus Bundles in the stem and petiole more or less scattered

### *Key to the genera*

A Carpels confluent with one another or with disc uniseriate thus forming nearly one ovary plants more or less armed

(1) Plants somewhat armed leaves cordate perianth more or less hypogynous carpels many adnate to the disc — *Nymphæa*

(2) Plants much armed leaves peltate perianth more or less epigynous ovary 8 celled — *Euryale*

B Carpels scattered embedded in pits turbinate truncate receptacle plants unarmed leaves peltate perianth *hypogynous* — *Nelumbium*

## Genus—NYMPHÆA

Large gregarious aquatic herbs, with creeping rhizome Leaves oblong orbicular, cordate with entire or sinuate toothed margin Sepals 4 adnate to the torus Petals in many series Stamens many, filaments petaloid, anthers small linear Ovaries many, uniseriate all immersed in the fleshy receptacle appearing like a many celled ovary crowned with radiating furrowed stigmas Fruits spongy berry like ripening under water Seeds arillate

### *Key to the species*

A Flowers larger margin of leaves sharply sinuately toothed Sepals ribbed anthers without appendages stigmatic rays with clubbed appendages

(1) Flowers white — *N lotus*

(2) Flowers red — *N rubra*

B Flowers smaller margin of leaves entire rarely obtusely sinuate or waved Sepals not very much ribbed anthers often with long appendages

(3) Flowers white or variously coloured smaller than *N cyanea* — *N esculenta*

(4) Flowers often white or pale blue or variously coloured rarely yellow — *N stellata*

(5) Flowers deep blue . . . . . *N cyanea*

NYMPHÆA LOTUS Linn. (Bara Salook, Pl. I, Fig. 1.)

Perennial aquatic plants. Leaves when young pink, 6-18 inches in diameter, slightly peltate, deeply cordate, somewhat sagittate, downy underneath, smooth and shining above, margins shortly sinuate toothed, apex nearly acute. Flowers sweet-scented, large, 4-10 inches across. Sepals 4, 5-10 ribbed, linear, oblong, obtuse. Filaments of the stamens broadly dilated at the base; anthers without appendages. Stigmatic lobes with clubbed appendages; Fruit about 20 celled berry like, fleshy green with persistent sepals. Seeds broadly ellipsoid, rough.

*Hab.* In fresh water pools, jheels, etc., all over the warmer parts of India; flowering nearly throughout the year, chiefly during the rains and after.

NYMPHÆA RUBRA Roxb. (Lal Salook, Photo 1.)

The characters are more or less the same as *N. lotus*. The difference mainly lies in the colour of the flowers, which are of different shades of red and pink. This species also grows in the same habitat as that of *N. lotus*. Flowers have mild sweet scent as that of *N. lotus.*

NYMPHÆA ESCULENTA Roxb. (Chota Sundi, Pl. III, Fig. 4.)

Perennial aquatic plants. Leaves more or less similar to those of *N. lotus*, sagittate, broadly obtuse, nearly rotund at the apices, slightly downy underneath, margins entire. Flowers white, smaller than those of *N. lotus* and *N. cyanea*. Sepals and petals of intermediate form between *N. lotus* and *N. stellata,* stigmatic rays incurved. Berries of the size of nutmeg, 10-15 celled.

*Hab.* In freshwater tanks, etc., not so common as *N. lotus* and *N. rubra.*

NYMPHÆA STELLATA Willd. (Choto Shalook, Pl. I, Fig. 3.)

Perennial aquatic herb. Leaves quit entire, orbicular or oval elliptic, dorsal surface often blotched with purple, basal lobes broadly obtuse. Flowers small, very mildly odorous, white or pale blue or variously coloured, sometimes yellow; sepals 4, not ribbed but many veined with narrow fine purple lines, narrowly linear lanceolate, acute. Petals 8, linear, lanceolate, acute. Stamens 15-29, apices of the anthers foliacious with tongue-shaped appendages. Stigma 8 rayed. Fruits globular. Seeds with longitudinal striations.

*Hab.* Common throughtout the warmer parts and flowering the whole year. Roxburgh considers this species as " the smallest Indian species of the genus ".

NYMPHÆA CYANEA Roxb. (Neelpadma, Pl. I, Fig. 4.)

Perennial aquatic herb. Leaves peltate sagittate. smooth margins slightly wavy, dentate or even. Flowers of medium size, smaller than those of *N. lotus* and *N. rubra*, deep or pale blue, hardly scented. Sepals 4, not ribbed. Petals 8-12, linear, or lanceolate, sub-acute.

Stamens in 2 series. Stigmatic rays short, 10-12. Berries globular, ½ the size of those of *N. lotus*, 10-12 celled.

*Hab.* In tanks, jheels, ricefield, etc., throughout the warmer parts of the country, especially common in the Orissa district.

The systematic position of the different species of Nymphæas is slightly complicated due to variations in colour of the different varieties and forms Roxburgh in his " Flora Indica " dealt with six species :— *viz.*, *N. rubra, N. lotus, N. versicolor, N. cyanea, N. esculenta* and *N. stellata.* Hooker in his " Flora of the British India " has justly reduced these different species of Roxburgh to two recognised species, namely, *N lotus* and *N stellata,* the rest are reduced to varieties *N alba* of Kashmir and *N pygmæa* of the Khasia Hills are recorded also by Hooker as two undoubtedly distinct species. Prain and later writers have evidently followed Hooker, but Prain has retained *N. rubra* as a separate species due evidently to its definite character of '*red*' colour of the flower. But this red colouration exhibits, however, various shades in different individuals, and even in different whorls of the petals in an individual flower Strictly speaking, therefore, there is not much ground for considering *N rubra* as a species different from *N lotus.*

Prain has further considered *N. esculenta* of Roxburgh as a synonym of *N. lotus* But this clashes with the characters of his key where he mentions *N. lotus* is characterised by having ' leaves sharply sinuately toothed ' whereas the leaf of *N. esculenta* is ' entire '. The writers, therefore, prefer to put it under the section ' leaves entire ' to which the *N. stellata* lot belongs. But *N. esculenta* in other respects appears to be a form intermediate between the *N lotus* and *N stellata* groups We think that the proper place for this species is, therefore, between *N. lotus* and *N. stellata* and as much we have placed it as the first species of the *N. stellata* sub-section As regards the varieties *Cyanea, N. stellata* We have, however, preferred to give *N. rubra, N. escu- parviflora, major* and *versicolor,* we consider them as different forms of *lenta* and *N cyanea* the specific rank, as these are the common specimens of *Nymphæas* found is tanks, jheels, pools, etc. and popularly taken as separate species

It may be mentioned that by horticultural manipulation the flowers of *Nymphæas* and Nelumbiums are subject to variations in colours. The species which yields easily is *N. stellata*

Of Nymphaeceae *Nuphur luteum* (yellow water lily) the well-known temperate species can be grown in the gardens in this country as well without much difficulty. Another member of the same family *Victoria regia* (The giant water lily of the Amazon) is of the same habit as that of *Nymphæa* But it has leaves of enormous size about 6-7 ft. in diameter with an edge turned up to a height of about 3 inches, the *lower* side with projected ribs armed with spines Flowers very large, pale yellow. Fruits like those of *Nymphæas* but fully epigynous The plant is gradually but very slowly being acclimatised in this country. The leaves and flowers here are not so large as in their original habitat

(Photo VI). It was discovered in 1801 but was not sufficiently known till 1837. Seeds are eaten by Brazilians.

The Nymphæas are used plentifully for ornamental purposes. Leaves and fruits are said to be edible. These species especially the *N. rubra* and *N. cyanea* are used for medicinal purposes.

### Genus—EURYALE.

A perennial densely spinous rooted water-plant with a thick root-stock. Leaves orbicular mostly spherical, corrugate. Flowers violet partially submerged. Sepals 4. Petals numerous, shorter than the sepals. Stamens many, grouped in bunches of 8. Ovary 8 celled, sunk in the dilated top of the thalamus; stigma discoid, depressed, concave. Ovules not many on parietal placenta. Fruit a spongy berry crowned with persistent sepals and covered with stout prickles. Seeds 8-10 with pulpy aril.

#### EURYALE FEROX *Salisb.* (Pl. II, Fig. 1.)

A rooted perennial aquatic herb, very deeply rooted by means of thick fleshy fibrous roots. Stem very small. Leaf buds curiously folded up in an involucre which bursts when the leaf expands. Leaves large, round or oval, 1-4 feet in diameter, peltate, entire upper surface dark green, covered with a few purple spines, lower surface armed with strong straight sharp spines; petioles also armed. Peduncles also armed with prickles, ending in a single flower blossoming either almost above or below the surface of the water. Flowers rose, red or violet. Sepals 4, caducous, erect, armed with more or less recurved spines outside smooth and coloured inside. Petals about 20 in number 3-5 seriate, shorter than the sepals, narrowly ovate-oblong, the outer ones larger, the inner ones diminishing in size till when near the stamens they become very small and nearly colourless. Filaments of the stamens similarly reduced in size towards the centre; anthers oval. Ovary 8 celled, embedded in the top of the torus; style absent; stigma peltate, cup shaped, with about six rays. Berries prickly, oval or globular, slightly larger than an orange, sometimes irregular in shape due to swelling in many places by the growth of the seeds. Seeds of the size of a pea to a cherry, with pulpy arillus.

The fruits are sold in the bazar and are much eaten by the Chittagonians and Manipuris. The seeds are roasted and eaten. The plant is supposed to have powerful medicinal virtues.

### Genus—NELUMBIUM.

One of the most common of perennial aquatics, rooted in the mud with a creeping rhizome embedded in the mud. Leaves peltate, younger ones often floating on the surface but in very shallow water before the rains raised above the water. Flowers large white, red or rarely yellow. Calyx and corolla sometimes indistinguishable. Sepals 4-5. Petals many, those nearer the stamens becoming staminodes. Stamens hypogynous, numerous. Carpels many, sunk in the fleshy thalamus. Fruits consist of obovoid ripe carpels.

NELUMBIUM SPECIOSUM Willd (Padma Pl II Figs 2 & 4)

• A somewhat erect large perennial waterplant rooted in the mud with trailing jointed rhizomes Leaves 1 3 feet in diameter membranous peltate glaucous of a soft velvet like structure so that the leaves do not get wet on the upper surface petioles long often erect worted with pores Flowers large solitary at the apices of scapes, opening above the water faintly odourous rose red or white rarely pale yellow Sepals 4 5 passing into petals and stamens elliptic concave caducous hypogynous Stamens many Anthers linear nearly as long as filaments elevating their apices a little above the receptacle each anther crowned with pearl white clubbed appendage Receptacle obconical, more or less truncate at the top spongy 3-4 inches high Ovaries many one celled about 10 30 sunk in the torus Style scarcely any stigma some what bell shaped fleshy Fruits of ovoid ripe carpels Ovules pen dulous seeds feeling the carpels from the size of a pea to a cherry oval in shape Propagated chiefly by rhizome and also by seeds

*Hab* Everywhere in ponds pools lakes jheels all over the Indian Empire

The plant is well known for its most beautiful flowers which are used for decorative and religious purposes by the Hindus who consider them as the most sacred of flowers The plant is used for various economic and medicinal purposes It flowers profusely before and after the rains A lotus tank with flowers presents a charming spectacle

The lotus is easily distinguished in the field by its flowers which opens after sunrise in the stronger rays of the sun and closes after sun set—unlike those of the *Nymphœas* which open after sunset in the feebler rays of the sun and close after sunrise and sometimes partially opening during cold and cloudy days This is why the *Nymphœas* are known as *Kumudini* or *Chandrabikasi* as they open with the moon and the Nelumbiums—*Suryabikasi* as they open with the sun

Both the red and white lotuses are common in Bengal Yellow lotus—a horticultural variety—is also grown in some gardens Although botanically the variation in colour does not entitle these two plants—white and rose red lotuses to have specific rank yet for all practical purposes they may be given rank of horticultural variety Moreover there are some other minor characters mentioned by Roxburgh which justify to a certain extent their separation to two varieties Hence the rose to red coloured lotus may be called variety *rubra* and the white variety *alba* so also yellow coloured variety *luteum*

## Family—LEGUMINOSÆ

The aquatic members of this family are mostly herbaceous or shrubby Leaves stipulate alternate commonly pinnate Inflorescence axillary leaf opposed or terminal racemose Flowers usually irregular hermaphrodite rarely regular or polygamous Sepals united or free Petals usually free and unequal Stamens normally ten Ovary free style simple stigma capitate terminal Fruit a dry dehiscent pod

Leguminosæ is the third largest family of the flowering plants containing about 12,000 cosmopolitan species. This family is sometimes divided into three sub-families, namely :—

(1) *Papilionatæ* with typical zygomorphic papilionaceous flowers.

(2) *Cæsalpinioideæ* with irregular zygomorphic flowers and imbricate ascending aestivation.

(3) *Mimosoideæ* with regular flowers and valvate corolla.

This is one of the most important economic plant family supplying important food stuffs both to animal and human beings. The species *Neptunia oleracea* and *Sesbania paludosa* represent two important aquatic species of some economic value. The leaves of *Neptunia oleracea* are sensitive and exhibit sleeping movement when touched, like those of *Mimosa pudica* due to the presence of a motor tissue in the pulvinus. The members of this family are also well known for their power of absorbing atmospheric Nitrogen by their root tubercles.

## *Key to the genera.*

A. Corolla papilionaceous Flowers axillary not in head irregular petals imbricate.

(1) Stamens usually diadelphous—(9 and 1); anthers apiculate; pods distinctly transversely septate between the seeds . . . . . . . *Sesbania.*

(2) Stamens in two bundles of 5 each; anthers exerted from the calyx, not apiculate but uniform . . *Æschynomene.*

B. Corolla not papilionaceous. Flowers in round head nearly regular; petals valvate.

(3) Stamens neither diadelphous nor in two bundles but definite usually 10. Anthers glandcrested . . *Neptunia.*

## Genus—SESBANIA.

Soft wooded erect tall herb or shrub. Leaves long, narrow, paripinnate with linear-oblong, deciduous, obtuse, mucronate leaflets. Flowers in long axillary racemes. Calyx companulate, 5 toothed or bilipped. Corolla with all the petals long clawed. Stamens diadelphous. Ovary long stalked. Legumes linear pendulous.

### SESBANIA PALUDOSA Prain.

A tall annual unarmed marsh plant some 6-12 ft. in height with tree like stems. Stems erect soft wooded, not piped but the parts under water inflated and clothed with fibrous roots. The bark is green. The proportion of the exposed and submerged parts depends on the water level. Leaves 6-12 inches long, sessile, abruptly even pinnate, exhibiting the usual sleep movement; leaflets mostly 10-30 pairs, opposite, obtuse, linear oblong, slightly tapering towards the base, mucronate 1 to 1½ inch long up to ⅜ in. broad. Stipules more or less lanceolate, caducous. Racemes varying in length relative to leaves. Flowers drooping bright yellow, dorsal side of the standard spotted with round purple dots. Bracts solitary; bracteoles 2 adjoining the calyx. Fruit a pendulous legume, 10-12 in. long, slightly and abruptly depressed between the seeds. Septate within between the numerous seeds.

*Hab* A cosmopolitan tropical species Widely distributed spreading over the plains It grows profusely during the rains forming more or less pure association in the marshy and flooded areas of Bengal

## Genus—ÆSCHYNOMENE

Erect herb or undershrub of marshy land and borders of jheels and lakes Leaves imparipinnate leaflets small linear stipules lanceolate flowers in simple or compound raceme axillary rarely terminal Calyx bilipped Corolla papilionaceous stamens diadelphous 5 in each of the two bundles Ovary stalked style filiform stigma terminal Pod linear long a stalked lomentum

### *Key to the species*

| | |
|---|---|
| A Stems slender branches many diffuse peduncles viscid sepals and smaller petals smooth | *A indica* |
| B Stems stout branches rather erect peduncles not viscid sepals and larger petals hispid | *A aspera* |

### ÆSCHYNOMENE INDICA Linn (Pl IV Fig 3)

An annual rather diffuse herb or undershrub glabrous pale green more or less round branches Leaves odd pinnate leaflets fewer in number than in *A aspera* Stipules lanceolate membranous deciduous with a large auricle Flowers in copious axillary racemes peduncles viscid bracts small lanceolate Calyx of 5 deeply bilipped united sepals lips entire or toothed Petals dropping off as the flowers open, twice the size of the sepals standard orbicular slightly clawed wings obliquely obovate o oblong incurved Stamens in two bundles of 5 each Ovary stipitate 2 many ovuled style filiform incurved stigma terminal somewhat capitate Fruit a long stalked lomentum with 2 8 flattened seeded separating joints

*Hab* Widely distributed from the Himalayas to Ceylon ascending up to 5 000 ft

### ÆSCHYNOMENE ASPERA Linn (Pl IV Fig 2)

A robust sparsely branched tall erect shrubby species of swamps with stout more or less glabrous 2 6 feet high fistulous white pithed stems Leaflets more in number than in *A indica* Racemes corymbose 2 6 *flowers axillary or terminal Flowers pale yellow Bracts ovate* cordate pedicels and peduncles covered with spares bristles Calyx bilabiate with a pair of bracteoles Corolla twice the calyx Pods smooth or echinate

*Hab* Common in Bengal extending to the Malay Islands Of these two species the latter is the stouter and due to its taller and robust shrubby character can easily be distinguished in the field This species is of considerable commercial importance due to its use for shola hats and other articles manufactured from the white soft pith of the plant It is noted that the leaves are sensitive but we have failed to find much sensitiveness except the usual sleep movement

### Genus—NEPTUNIA.

Annual or perennial aquatic herbs or undershrubs. Leaves evenly bipinnate, stipulate; leaflets small sensitive. Stipules persistent; stipels absent. Flowers in heads, upper hermaphrodite, the lower male and the lowest neuter with petaloid staminodes; bracts minute, bracteoles absent. Calyx minute, campanulate, 5 toothed. Corolla with 5 petals, connate at the base. Stamens 5-10 exerted. Anthers glandcrested. Ovary stipitate; style filiform; stigma club-shaped. Fruit a flattened oblong bivalved pod.

*Hab.* A cosmopolitan genus in the tropics and subtropics spreading from North Western India to Ceylon and the Malay Archipelago.

#### NEPTUNIA OLERACEA Lour. (Pl. IV, Fig. 4.)

Aquatic herb or rarely undershrub, with prostrate or nearly creeping round, piped, jointed floating stem or branches, rooting at the nodes; composed of aerenchymatous tissue (spongy), tissue which prevents the plant from sinking in the water. Leaves alternate, evenly bipinnate 2-3 inches long, pinnae 2-3 pairs; leaflets 8-15 pairs glabrous, obtuse, ⅓ to ½ in. long, sensitive; stipules ovate cordate, caducous, stipels absent. Peduncles erect, axillary, single longer than the leaves, bearing at the apices an oblong or ovate globbose head of fertile, male and neuter flowers. Bracts solitary, one flowered, lanceolate. Fertile flowers above, male and neuter below—the lowermost neuter flowers having ten petaloid staminodes. Calyx five toothed. Corolla five petalled. Stamens in hermaphrodite and male flowers 10 rarely 5, free, staminodes in neuter flowers 10, exerted, protruding, linear lanceolate, more or less waved, yellow. Anthers gland-crested, pollen granular. Ovary stalked many ovuled; style filiform; stigma small, terminal, somewhat concave. Fruit a flattened coriaceous ligulate or oblong bivalved pod, dehiscing by the upper suture. 6-10 seeded.

*Hab.* Distributed nearly throughout the warmer parts of India. Flowering from the wet season to the cold weather, fruiting later.

A floating aquatic, widely creeping in marshes, flooded rice fields and sides of jheels, tanks, lakes and other stagnant shallow parts, producing ample tufts of fibrous adventitous roots which stick in the mud as the water recedes or dries up when the plant soon dies. The plant can easily be distinguished in the field due to its sensative leaves, leaflets collapsing when touched but recovering after a time.

## Family—DROSERACEÆ.

Insectivorous herbaceous plant. Leaves in rosettes, sensitive to touch which in Aldrovanda automatically close along the fold, others have strictly tentacles on them. Calyx 5. Corolla 5, imbricate. Stamens 5, hypogynous. Ovary globbose or ovoid, 1-3 celled; placenta parietal-rarely axile; style long; stigmas simple branched. Ovules 3-many, fruit loculicidal capsules.

### Genus—ALDROVANDA.

A rootless floating aquatic herb with jointed stem. Leaves whorled, spathulate, orbicular, lamina contorted bladder-like. Flowers stalked,

solitary, axillary Sepals 5. Petals 5 Stamens 5 hypogynous, filaments needle shaped Ovary unilocular, styles 5 with terminal branching stigmas Fruit a membranous 5 valved capsule Seeds numerous black shining

ALDROVANDA VESICULOSA Linn (Pl V, Fig 4)

A floating water plant, leaves sessile, vesicular wedge-shaped, smooth, whorled with a stalk portion and a blade-capturing and digesting small animals, shutting automatically along the midrib with the touch of the animals

This interesting insectivorous plant has been reported to occur in the salt lakes south of Calcutta Roxburgh notes " found swimming on ponds of water over Bengal during the cold and hot season " The authors have made a thorough search in the localities mentioned, but up till now they have not been able to find it nor has it been recently recorded

## Family—HALORAGÆ

Mostly aquatic herbs Leaves opposite or in whorls, rarely partly alternate submerged leaves pectinate Flowers hermaphrodite or unisexual axillary solitary or in clusters, the whorls often appearing as spike Calyx lobes 4 or absent, petals 4 or absent Stamens 2-8 or single, epigynous in the hermaphrodite flowers Ovary 4-2 or 1 celled, styles 4-2 or 1, fimbriate or simple Fruit dry or drupaceous indehiscent or dehiscent, separating into carpels

*Key to the genera*

| | |
|---|---|
| A Aquatic stamens 2 8 | *Myriophyllum* |
| B Terrestrial stamens 8 | *Serpicula* |

## Genus—MYRIOPHYLLUM

Mostly rooted, smooth water plants with floating stems Leaves whorled, dentate, serrate when above the surface of water, pectinate-pinnatifid when under the surface Flowers monœcious or hermaphrodite, sessile or subsessile, borne at the axils of floral leaves, or in nearly naked spikes raised above the surface of water Male flowers Sepals 2-4 Petals 2-4 Stamens 2-8 In female flowers sepals 4 connate in a furrowed tube, lobes absent or of 4 minute teeth Petals minute or absent Ovary inferior 4 2 celled, styles 2-4 stigmas plumose Ovules solitary, pendulous Fruit dehiscent, 4 furrowed or separating into 4 or 2 carpels

*Key to the species*

| | |
|---|---|
| A Floral leaves linear crenate toothed upwards Flowers pink Stigmas pink much fimbriate Fruits acutely ridged along carpel backs both ridges and furrows beset with pointed tubercles | *M tuberculatum* |
| B Floral leaves narrow lanceolate or linear lanceolate upper entire or crenate Flowers white Stigmas green little fimbriate Fruits with rounded ridges along carpel backs, or glabrous tubercled or not | *M indicum* |

### MYRIOPHYLLUM TUBERCULATUM Roxb. (Pl. VII, Fig. 1.).

A perennial aquatic herb with smooth creeping rhizomelike round jointed, either embedded in mud or floating stems with erect extremeties above the level of the water. Leaves verticelled of two kinds, those above the water simple, acutely dentate or serrate or pinnatifid, below the water-level much larger with capillary segments. Spikes terminal or subterminal, with linear, cuneate,-toothed floral leaves, having upper whorls of male flowers, lower of female, sometimes of hermaphrodite flowers also. Flowers whorled one at the axil of each floral leaf, pink coloured. Sepals none. Petals pink, oblong expanding, stamens often 4, filaments short, anthers linear, stigmas pink, much fimbriate. Fruit a 4 furrowed nut or drupe. Seeds pendulous, cylindric, oblong. United in the form of a four lobed tubercled pericarp.

### MYRIOPHYLLUM INDICUM Willd.

The description is similar to *M. tuberculatum*, differing only in having floral leaves linear lanceolate upper entire or crenate; upper whorl of male flowers, lower of female, intermediate often hermaphrodite. Stamens 4. Stigma green. Fruit scarce, much broader than in *M. tuberculatum*, 4 carpels rounded on the back but separated by wide furrows, tubercled and puberulous or finally quite glabrous.

*Hab.* Both the species are common in the stagnant and partly flowing freshwaters of jheels, lakes, pools and puddles. Common in Bengal, Assam and Burma. Flowering and fruiting almost throughout the season.

These plants not infrequently form pure associations choking up pools, puddles, stagnant beds of streams or khals sometimes perennating by means of winter buds like those of the Utricularias and Hydrilla. The congested association of these plants leads to such stagnation of water as to form a suitable ground for breeding mosquitoes.

### Genus—SERPICULA.

Herbaceous marsh plant. Leaves opposite or alternate often in the same plant. Flowers monœcious. Male flowers with 4 sepals, 4 petals and 8 stamens and 4 rudimentary stigmas. Female flowers with 4 sepals, petals and stamens absent. Ovary one-celled style 4; stigmas papillose or plumose. Fruit a nut, one seeded, 8 ribbed, smooth.

### SERPICULA INDICA Thwaites.

A herb in marshy areas, leaves obovate or obovate oblong, dentate-serrate, usually minutely ciliate along the margins, generally opposite or the upper and lower ones alternate. Flowers clustered in the axils, with male flowers pedicelled, females sessile. Fruit nearly smooth.

*Hab.* In waterlogged boggy or marshy lands. Common in Ceylon and in the Deccan Peninsula.

## Family—ONAGRACEÆ.

Annual or perennial, terrestrial or aquatic herbs or rarely under-shrubs; in aquatic species stems clothed with submerged assimilatory

roots (as in Trapa) or floating roots for aeration (as in Jussiæ). Leaves alternate or opposite sometimes more or less whorled, exstipulate, entire or toothed Flowers solitary, or in axils or in spikes or racemes borne at the apices of branches, regular or subregular. Calyx lobes 4. Petals 4. Stamens as many as or twice as many as petals inserted with them. Style 1, cylindric or subulate, stigma bilobed or quadrifid Ovules one or more in each cell Fruit usually a loculicidal capsule, sometimes a nut or a berry.

*Key to the genera*

| | |
|---|---|
| A Plants rooted in the mud along the margin of jheels etc with floating stems furnished with tufts of white spongy special aerating roots at or above the nodes and bunches of adventitious roots below Stamens twice as many as Calyx lobes 8 10 12 Seeds numerous not comose unarmed | *Jussiæa* |
| B Tropical aquatic submerged plants with green assimilatory or filiform (adventitous) roots under water and rhomboidal floating leaves with spongy dilatations on the leafstalk Stamens 4 Fruit armed with spines seed solitary | *Trapa* |

## Genus—JUSSIÆA

A prostrate or creeping marsh or aquatic herb Leaves alternate undivided, mostly entire Flowers yellow or white, solitary, axillary, pedicels 2 bracteate Calyx tube not produced beyond the ovary; lobes 4-6, acute persistent Corolla lobes 4-6, epigynous Stamens double the number of petals (8-10-12) Ovary 4-5 celled inferior; style simple stigma 4-6 lobed Capsule linear, round or angular 4-6 celled, 8-10 ribbed, seeds many, without coma.

### JUSSIÆA REPENS Linn (Pl XII, Fig 4)

Creeping or floating perennial water plants, stems furnished with white tufts of aerating roots at the nodes and below with bunches of fibrous roots in the water. Leaves obovate or oblanceolate, tapering at the petiole Flowers white Petals 5 rarely 6 Capsule woody linear, cylindric; seeds smooth, quadrate reticulated, with white corky *testa*

*Hab* Common throughout India in freshwater, lakes, jheels and other marshy and swampy areas. Flowering during the rains.

The other species *Jussiæa suffruticosa* Linn is also common except in the drier parts This species differs from the former by its more or less erect stems, larger lanceolate, somewhat villous acute leaves and by its yellow flowers having 4 petals

Both these species of *Jussiæa* are furnished with whorls of inflated white spongy aerenchymatous breathing roots floating on the water. These roots were formerly supposed to be floaters but subsequent investigation proves that they are aerating organs, as the roots are found to disappear when the water recedes or the plants get stranded on the muddy soil. They are then converted into normal roots When these tufts of roots are removed the plants are still found to float freely without them

## Genus—TRAPA.

Floating submerged strangling herb frequently choking up lakes, tanks, jheels, etc., with floating leaves and submerged assimilatory adventitous roots. Leaves, resolute rhomboid, petiole with spongy aërenchymatous inflations maintaining buoyancy of the leaves floating on the surface of water. Flowers white, axillary, solitary peduncled. Sepals 4, connate in a short tube adnate to the ovary, persistent, two or all the four developing into spines in fruit. Petals 4, white inserted on the margin of the epigynous disc. Stamens 4. Carpels 2, connate, in a half-inferior 2 celled ovary with a conical vertex; ovules solitary, anatropous; style subulate; stigma capitate. Fruit a 2-4 horned nut. Seeds exalbuminous with unequal cotyledons.

### * *Key to the species.*

A. Plants stouter, leaves larger, lamina about 2 inches long and 3 inches wide, very villous beneath. Fruit with strong well developed scabrous spines . . . *T. bispinosa.*

(1) Leaves like those of *T. natans* or of *T. Maximowicksii* but fruit like that of *T. bispinosa* . . . *var. incisa.*

B. Plants rather delicate, leaves nearly half the size of those of *T. bispinosa,* sparingly villous, rather thinner in texture and sometimes in hilly areas and high altitude plants somewhat membranous, deeply dentate or incise dentate on the anterior margin with rather long narrow, slender petiole. Fruits with 2 lateral spines undeveloped or rudimentary . . . . . . . . *T. natans.*

C. Plants neither very delicate nor very stout much less villous beneath. Petiole not so long and narrow as in *T. natans,* leaves incise-serrate on the apical portion. Fruit with all the four horns well developed. Spines hardly scabrous . . . . . . . . . . . *T. Maximowicksii.*

(2) Fruits with 2 straight and barbed horns well developed or with 2 horns and 2 reduced lateral horns . . *var. bicornis.*

### TRAPA BISPINOSA Roxb. (Pl. III, Fig. 1.)

A widely spreading partly floating and partly submerged water plant, with assimilatory adventitious fibrous free floating roots developed from the leaf bases. Stems long, stoloniferous. Leaves petioled, alternate rather crowded at the apex of the shoots, rhomboidal reniform in shape, with the basal margin entire and apical serrate, dentate, smooth or highly crenate, petiole villous elongating with the age of the leaves, portion above vesicle shorter than portion below. Peduncles axillary, solitary, shorter than the petioles one flowered. incurved when young bending down after the decay of the flowers. Flowers white, expanding above the surface of the water towards the afternoon. Sepals 4, petals 4, contracted. Fruit a nut, triangular, turbinate, as long as broad, hairy or glabrous with two angles developing into retrorsely scabrous spines, the other two angles often obsolete.

Var. incisa. A more or less intermediate plant between *T. natans* and *T. bispinosa* with leaves like those of *T. natans* and fruits like those of *T. bispinosa.*

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* The classification is drawn up in the light of the latest researches of Prof. Gluck of the Heidelberg University whose remarks are noted on the sheets of this herbarium supplemented by recent collections and field observations of Mr. K. Biswas.

*Hab* Throughout India in lakes, jheels, ponds, pools and puddles extensively cultivated Flowering during the rainy season fruiting later and ripening in the cold season

### TRAPA NATANS Linn (Pl XX, Fig 3)

A less common plant floating in rather deeper water Leaves distinctly smaller than in *T bispinosa,* deeply dentate or incise dentate on the anterior margin, petiole rather long narrow with less prominently developed spongy swelling glabrescent Fruit with 4 angles all spinescent but the lateral spines frequently shorter or obsolete

*Hab* Mostly confined to the hilly areas in comparatively high altitudes such as in Kashmir (Dal Lake) and Manipur (Loktak Lake) Assam

### TRAPA MAXIMOWICKSII Kors

A rather uncommon plant not very stout much less villous beneath Leaves smaller than in *T bispinosa,* lightly or deeply dentate-serrate, petioles shorter than in natans slender with slight or no inflations, fruit with all the 4 angles developing into spines

Var bicornis Fruit with 2 rather recurved obtuse horns occasionally 3, or with 2 horns and 2 reduced lateral horns

*Hab* In lakes and pools of Sylhet, Bengal

## Family—UMBELLIFERÆ

Species in India nearly all herbaceous Leaves alternate, divided or dissected rarely simple, petiole generally ending in a sheating base Flowers hermaphrodite or polygamous in simple or compound umbels Calyx lobes 5, adnate to the ovary petals 5, stamens 5 epigynous Ovary 2 celled, styles 2, stigmas 2 capitellate Fruit of 2 indehiscent dorsally or laterally compressed carpels separated by a commissure

### Genus—OENANTHE (Pl VI Fig 1)

Herbs of marshes or floating on the surface of stagnant pools, jheels, tanks etc Floating plants with profuse tufts of fibrous roots or roots creeping or stoloniferous Leaves 1-3 pinnate, ultimate segments large or linear or minute rarely reduced almost to sheaths Inflorescence compound umbels Flowers white, polygamous, males sometimes radiant Carpels 2 connate Styles short Fruit globbose or ellipsoid Seed terete or dorsally compressed

### OENANTHE BENGALENSIS Benth

A glabrous small erect herb with fibrous roots common on muddy banks or swampy areas or freely floating Leaves pinnately decompound secondary pinnæ lanceolate or ovate often deeply pinnatifid ultimate segments never linear, petioles canaliculate especially towards the base Umbels compound often sessile Bracteoles several linear Sepals small united in a calyx tube with acute teeth Petals 5 uniform,

white, ovate with long inturned points. Stamens 5. Carpels subquadrate ellipsoid; dorsal and intermediate ridges usually distinct, scarcely prominent. Furrows vittate. Carpophore absent; disc not usually prominent. Fruits ovate or ovate-oblong, crowned. Seed cylindrical tapering or dorsally compressed with flattened inner surfaces.

*Hab.* Annual tending to perennial, common throughout Bengal, Assam and lower Burma. Flowering during and after the rains. It is also found to grow in shady moist places along the edges of tanks or stranded in wet land in dry season too.

## Family—COMPOSITÆ.

This is the largest fam'ly of the flowering plants. Herbs, shrubs rarely trees. Leaves alternate rarely opposite or whorled. Inflorescence a capitulum or a centripetal head of many sessile flowers on the top of the dilated receptacle enclosed by involucre of whorled bracts. Flowers of disc and ray florets. Disc florets hermaphrodite, ray florets female, or neuter. Pappus calyx; corolla of two forms of ligulate flowers the lobes of which are elongate and united in a strapshaped or elliptic ligule; of disc florets tubular, campanulate, 4-5 lobed, lobes valvate with marginal nerves. Stamens 4-5 inserted within the corolla tube; anthers syngenesious. Ovary one celled; style slender bifid. Fruit a cypsela.

### Genus—ENHYDRA.

A herbaceous marsh plant with stems and branches glabrous or somewhat rough to the touch (Scaberulous). Leaves opposite, sessile. Flower heads axillary, subsessile heterogamous, subradiate; ray florets female, many seriate, fertile; ligule minute, broad 3-4 toothed. Disc florets hermaphrodite, fertile or the inner sterile, tubular limb fivefid. Involucral bracts 4, foliaceous, in opposite pairs, 2 outer ones larger, rather cordate, obtuse. Receptacle convex or rather conical. Pales enclosing the flowers tipped with glandular hairs. Anthers basifixed, bases obtuse entire. Style arms of hermaphrodite flowers, obtuse, with hispid tips. Achenes oblong enclosed in rigid pales, outer dorsally, inner sometimes laterally compressed. Pappus absent.

ENHYDRA FLUCTUANS Lour. (Pl. VI, Fig. 2.)

A glabrous or pubescent, usually quite smooth, spreading, marshy herb, common along the sides of jheels, tanks, etc., sometimes partly floating in water or creeping on marshy land with stem elongate, simple or divaricating branches, rooting at the nodes and projecting above. Leaves sessile more or less stemclasping linear oblong, acute or obtuse, entire or subcrenate, marked with glands. Heads axillary or terminal, sessile. Calyx limb obsolete. Petals of ray florets connate in corollas shorter than their styles with short, broad, 3-4 toothed ligule; of hermaphrodite florets united in regular tubular corollas with a campanulate 5 fid limb. Receptacle flat naked. Seed black, oblong without crown of pappus.

*Hab.* A perennial herbaceous species. Common throughout Bengal, Assam and Lower Burma. Flowering during the cold and hot season

sometimes during the rains, as well Used for various medicinal purposes

## Family—GENTIANACEÆ

Herbaceous sometimes aquatic or marsh plants Leaves opposite rarely alternate sometimes trifoliolate, exstipulate, usually entire. Inflorescence usually a dichasial cyme or umbellate, rarely solitary. Flowers regular rarely irregular, hermaphrodite, 4-5 merous, rarely more Calyx with 5 imbricate lobes Corolla lobes, 5 bell or funnel shaped, or rotate, lobes twisted to the right, not rarely induplicate, valvate Stamens as many as the corolla lobes, epipetalous, anthers oblong, disc of five glands at the base of the ovary or absent Ovary one celled, placenta usually parietal, style short or linear simple, stigmas 2 small Ovules numerous Fruit usually a septicidal capsule or rarely a berry, seeds small, many, sometimes winged

### Genus—LIMNANTHEMUM

Perennial water plants, rooted in the mud with leaves floating on the surface of water Leaves deeply cordate, entire or more or less sinuate, alternate or subopposite Flowers stalked, white or yellow, peduncles fascicled at the nodes Calyx of 4-5 partite slightly connate sepals Corolla rotate 5-4 fid, tubes often with glands opposite the lobes sometimes hairy on the throat Lobes valvate in bud, ciliate, fimbriate Stamens epipetalous 5-4, anthers hastate-oblong versatile Ovary 1 celled Style short, stigma 2-3 lobed Capsule ovoid oblong subdehiscent Seed orbicular nearly flat, compressed with spongy finely reticulated testa sometimes covered with papillose glands

*Key to the species*

A Stems floating rooting at the nodes
- (1) Corolla lobes entire with a longitudinal fold down the middle Seeds rough to the touch (scabrous) — *L cristatum*
- (2) Corolla lobes fimbriate densely papillose without a fold down the middle seeds almost quite smooth — *L indicum*

B Stem floating not rooting at the nodes
- (3) Leaves all orbicular deeply cordate corolla yellow seeds minutely reticulate glabrous — *L aurantiacum*
- (4) Leaves radical spathulate orbicular cauline orbicular deeply cordate corolla white seeds minutely puberulous — *L parvifolium*

### LIMNANTHEMUM CRISTATUM Griseb (Pl V, Fig 2)

A rooted aquatic with orbicular deeply cordate leaves Pedicels numerous, densely fascicled at the nodes Corolla tube with a ring of white hairs round the throat Petals 5-4, entire with a longitudinal fold down the middle. Stigma 3-4, often 3 ridged Capsule globose; seeds circular very thick somewhat compressed, lenticular, margins subacute, scabrous

*Hab* Very common throughout India with the leaves floating on the surface and white delicate flowers projecting above Gregarious in habit generally growing near the margins of tanks, jheels and lakes, in ricefields also

LIMNANTHEMUM INDICUM Thwaites. (Pl. V, Fig. 2.)

Stem long, floating rooting at the nodes. Leaves larger, than in *L. cristatum*, orbicular, deeply cordate. Pedicels numerous unequal densely fascicled at the nodes. Calyx lobes narrowly lanceolate. Corolla lobes fimbriated, densely papillose, without a longitudinal fold down the middle, white, yellow towards the base within. Capsule subquadrate; seeds numerous smooth or nearly so.

*Hab.* Throughout India, very common and of the same habit as the former species.

LIMNANTHEMUM AURANTIACUM Dalz.

Stem elongate not rooting at the nodes, leaves orbicular deeply cordate. Pedicels commonly 2 from each node. Calyx lobes 5. Corolla yellow, lobes sparingly fimbriate, without a longitudinal fold down the middle. Capsule subglobose. Seeds smooth; testa close, thick, minutely reticulate, not papillose.

*Hab.* East Bengal and Western Deccan Peninsula, from Bombay southwards—frequent in Ceylon.

LIMNANTHEMUM PARVIFOLIUM Griseb.

Stem apparently rooted on mud at the base, long, floating, not rooting at the nodes. Leaves small; radical spathulate, orbicular, deeply cordate, cuneate at the base on the broad petiole; cauline subsessile. Pedicels 3-10 at each node, fascicled. Calyx lobes oblong. Corolla white, lobes 5-4 fimbriate. Capsule oblong narrowed below, seeds minutely puberulous.

*Hab.* W. Deccan Peninsula—frequent along the coast lands of Chittagong down to Tavoy in South Burma.

## Family—HYDROPHYLLACEÆ.

Annual or perennial herbs. Leaves radical alternate or rarely opposite, entire or toothed. Flowers blue, scattered or in cincinni, regular, hermaphrodite, pentamerous. Calyx usually of 5 imbricate sepals. Corolla of 5 petals united in a rotate bell or funnel shaped tube, lobes imbricate. Stamens 5, epipetalous; filaments filiform often dilated at the base. Carpels 2 connate in a superior, uniloculor or imperfectly or perfactly bilocular ovary. Fruit a globose or ovoid loculicidal or septicidal bivalved or quadrivalved capsule.

### Genus—HYDROLEA.

Annual herbs or marshes. Leaves alternate, entire. Flowers blue in short terminal racemes or cymes. Calyx of 5 lanceolate sepals, divided nearly to the base. Petals 5, connate united in a widely campanulate, subrotate corolla. Anthers 5, oblong sagittate. Carpels 2, connate in a completely 2 celled ovary. Styles 2. Stigmas capitate. Fruit a septicidal or irregularly 4 valved capsule. Seeds minute.

HYDROLEA ZEYLANICA Vahl (Pl VI, Fig 3)

Annual unarmed, smooth procumbent or creeping branched herb of ricefield or marshy ground Leaves lanceolate, narrowed at the base, alternate, short petioled, entire, smooth Inflorescence often viscidly hairy Flowers on the extremities of short lateral branchlets, or solitary opposite to the leaves or between them, colour deep bright blue Bracts narrow Calyx divided near the base into 5 long narrow pointed or lanceolate striate hairy lobes exceeding the capsules Petals 5, longer than the sepals filaments shorter than the petals Anthers sagittate Styles 2 spreading Capsules superior

*Hab* Common throughout India ascending up to 4,000 feet in wet places, frequently abundant in wet ricefields and other swamps Flowering during the cold weather

Family—CONVOLVULACEÆ

Shrubby or often herbaceous climbing or twining plants Leaves alternate, exstipulate Flowers regular, hermaphrodite, generally pentamerous in one or many flowered cymes, rarely solitary Calyx deeply five lobed Petals 5, united in a campanulate or funnel shaped corolla, limb shortly or deeply lobed, often 5 plaited in bud, after flowering the limb either incurled or reverting to the original aestivation Stamens 5 adnate to corolla tube Anthers oblong introrse or lateral Ovary superior often surrounded by an annular disc of 2 carpels, 2 celled or frequently by the development of false partition walls 4 celled Style 1—rarely 2 Stigma capitate bifid or bilobed Ovules 2 in each carpel, sessile erect, anatropous Fruit an indehiscent berry or a 2 4 valved or circumscissile or breaking up irregularly into generally 4-2 rarely 1 seeded capsule Seeds erect, cotyledons generally plaited

Genus—IPOMŒA

Generally twining prostrate or climbing herbs or shrubs Leaves alternate entire, lobed or much divided Flowers solitary, axillary or in 1—many flowered cymes purple, white or yellow Bracts various Sepals ovate, or linear, equal or unequal in fruit erect or rarely patent Petals 5, connate in a campanulate or funnel shaped corrolla Limb plicate, margin very slightly lobed Stamens 5, unequal included or exerted Filaments filiform often dilated below, occasionally hairy Anthers straight or contorted Ovary 2 celled 4 ovuled rarely 4 celled 4 ovuled Style filiform stigma capitate, 2 lobed, globose Fruit generally 4 6 valved capsule Seeds 2-4 6, rarely 1.

IPOMŒA AQUATICA Forsk (Pl V Fig 1)

Perennial floating aquatic herbs, with creeping smooth, hollow jointed mostly floating stems, sometimes rooted in the mud by means of fibrous roots produced at the nodes Leaves alternate long stalked, elliptic, oblong-cordate or hastate entire, pointed smooth Peduncles long few-flowered, axillary erect, round, smooth, shorter than the petioles Flowers large, purple Sepals glabrous or nearly so, ovate, obtuse Corolla subinfundibuliform, lobes triangular, usually pale purple, glabrous Base of the filaments woolly Stigma two headed Capsule ovoid,

smooth, 4-2 seeded. Seeds nearly smooth or covered with minute silky hairs.

*Hab.* Common throughout India, especially abundant in Bengal, extending up to South Burma. Often cultivated as the leaves and young shoots are much relished by Indians and Burmans. The plant which is frequently found floating along the sides of lakes, tanks, jheels, etc., sometimes spreads over the surface and by its long rope like stems soon forms a network of vegetation choking up the surface of water. The juice of the leaves is taken as medicine which acts as mild purgative and is supposed to purify blood.

## Family—SCROPHULARINEÆ.

Herbs or shrubs, terrestrial or aquatic. Leaves opposite, rarely alternate or whorled. Flowers hermaphrodite, zygomorphic in centripetal or composite inflorescence. Calyx generally of five persistent, connate sepals. Corolla 4-5 lobed, more or less 2 lipped, occasionally personate. Stamens 4, didynamous, with or without a staminode. Disc annular, glandular, capshaped. Ovary commonly 2 celled. Style simple. Stigma capitate, dilated, bilobed. Fruit a capsule. Placenta axile or freecentral, remaining attached to the margins of the valves. Seeds small, various in shape.

### *Key to the genera.*

A. Stamens 4.

(1) Leaves opposite. Calyx 5 partite, segments equal. Stamens 4, anther cells disjointed, stalked. Capsules breaking into valves with the placentiferous dissepiment. Seeds angular . . . *Limnophila.*

(2) Leaves opposite. Calyx 5 partite, imbricate. Stamens 4, anther-cells contiguous. Capsule 2-4 valved, grooved, separating from an entire column . *Herpestis.*

B. Stamens 2.

(1) Leaves radical. Calyx 5 partite, lobes narrow, imbricate. Stamens 2, perfect, the anterior pair reduced to staminodes, anther cells parallel, distinct, equal. Capsule with placentiferous valves not inflexed . . . . . . . . . *Dopatrium.*

(2) Leaves opposite, calyx 4 partite. Stamens 2, lower perfect, upper absent or reduced to staminodes, anther-cells 2, parallel. Capsule bivalved, 2 fid or 2 partite . . . . . . . . . . *Bythophyton.*

## Genus—LIMNOPHILA. (Pl. V, Fig. 1.)

Glabrous or pubescent, often aromatic aquatic or marsh plants. The species of this genus are very variable, the foliage and habit varying according to the depth and nature of the water in which they grow. Leaves opposite or whorled, naked with transparent dots; the submerged ones are finely divided. Flowers sessile or pedicelled, axillary or solitary or occasionally borne on racemose or spicate inflorescences with leafy bracts. Sepals united in five partite calyx, lobes narrow subequal. Petals 5 connate in a bilabiate corolla. Stamens 4 didynamous, included; anther cells usually separate and stipitate. Style deflexed at the tip. Stigma shortly bilamellate. Fruit a loculicidal or septicidal, ovoid

or oblong capsule; valves bearing placentiferous septa. Seeds many, small, angular, truncate, reticulate.

*Key to the species.*

A Leaves with nerves pinnate, arching from the midrib, no whorls of pinnatifid or multifid leaves

Calyx lobes not striate in fruit

Leaves opposite, petioled, elliptic or ovate, obtuse or subacute crenulate, nerves prominent Flowers sessile, axillary in peduncled heads, rarely solitary Calyx lobes lanceolate, finely acuminate . . . *L Roxburghii*

Leaves 4 nately whorled, half stem clasping, linear, serrulate nerves obscure. Flowers very many, shortly pedicelled, small in panicled, terminal corymbs Calyx lobes subulate . . . *L polyantha*

Calyx lobes striate in fruit

Leaves petioled, elliptic ovate or oblong lanceolate, *subacute, all opposite Flowers racemose, sessile or* rarely pedicelled Calyx hirsute . . . *L diffusa*

Leaves sessile or rarely (as in *L conferta* sometimes) sub petioled

Flowers sessile leaves all opposite, calyx glabrous or nearly so

Leaves oblong or elliptic oblong, obtuse, crenate serrate, sessile or sometimes subpetioled, erect or diffuse herbs. Flowers double the size of those of micrantha, calyx lobes lanceolate acuminate . . . *L conferta.*

Leaves all opposite minutely punctate beneath Flowers rose purple, large sessile in the axils of opposite or alternate leafy bracts forming terminal and axillary sessile or peduncled spikes . . . *L hypericifolia.*

Leaves linear, entire or subserrate, always sessile Small herbs Flowers ½ the size of those of *L conferta*, (12 inches long) Calyx lobes subulate . . . *L micrantha*

Flowers pedicelled.

Leaves linear oblong serrulate, subacute, often 3 4 nately whorled Flowers in axillary or terminal many flowered racemes at the end of stems, rarely solitary, calyx lobes lanceolate, acuminate, pedicels usually longer than calyx. Calyx glabrate, capsule oblong . . . *L gratissima.*

B. Leaves 3-5 nerves, running from the base to the apex, or lower leaves whorled, pinnatifid or multifid, fruiting *calyx not striate*

Flowers sessile or very shortly pedicelled

Stem stout hirsute, leaves all 3-6 ternately whorled sessile, the uppermost elliptic or linear oblong, 3-5 nerved, the lowermost pinnatifid. Flowers cowded in erect, close, leafy spikes. Calyx lobes subulate . . . *L cana*

Stem always glabrous, leaves the 2 uppermost usually opposite, crenulate, the next below 4-6 ternately whorled, pinnate the lowest submerged, multifid with capillary segments; occasionally the uppermost flowers in a leafy spike, calyx lobes ovate, shortly acuminate . . . *L heterophylla*

Flowers pedicelled; pedicels as long as or longer than the calyx, calyx lobes ovate acuminate

Stem erect, stout, 1-2 feet high, flowers large 5-6 inches long usually in erect terminal racemes, upper leaves always sessile, ovate or linear-oblong, serrate, entire or 3 nate, lower multifid with capillary segments . . . *L racemosa*

LIMNOPHILA ROXBURGHII G. Don. (Pl. VI, Fig. 4.)

An annual erect aromatic pubescent or glabrous herb with creeping roots. Stems many, stout, nodes under water producing many filiform leaves. Leaves all opposite, short petioled, oblong, elliptic or ovate obtuse or subacute. Serrate or crenulate, a little rugose coriacious, gland-dotted or punctate beneath, nerves strong. Flowers solitary or grouped, usually in axillary sessile or short peduncled head, blue purple, mouth yellow. Calyx pubescent. Lobes lanceolate, finely acuminate, not striate in fruit, upper divisions largest incumbent. Corolla pubescent, campanulate, upper lip broader and emarginate. Nectary a yellow ring surrounding the base of the germ. Capsule illipsoid.

*Hab.* Common weed in water places and moist lands in Northern India and outer Himalaya ascending up to 6,000 feet from Chamba to Mishmi. More commonly seen in the plains and valleys of Assam, Bengal, Central India, the Concan and Circars. Roxburgh lays stress on the aromatic smell and taste which Hooker doubts.

LIMNOPHILA POLYANTHA Kurz.

A graceful glandular pubescent herb. Stem rather slender. Leaves except in starved forms all 4—nately whorled, ½ stemclasping, linear serulate, nerves obscure. Inflorescence terminal panicled cymes. Peduncles and pedicels very slender, bracteoles nearly as long as the calyx. Flowers numerous, small. Calyx lobes subulate in fruit striated or not. Corolla slightly smaller than the calyx. Capsule ovoid oblong.

*Hab.* In marshy areas of Sikkim Terai and also reported from Pegu, Burma by Kurz. The plant is easily distinguished by its habit of producing copious flowers borne on subpyramidal inflorescence.

LIMNOPHILA DIFFUSA Benth.

An erect or decumbent, pubescent low herb. Leaves all opposite nearly petioled, elliptic ovate or oblong lanceolate, subacute, crenate, serrate, pubescent, more strongly nerved than those of *L. conferta.* Flowers in short axillary cymes or long spikes or racemes. Flowers with hirsute calyx. Calyx lobes lanceolate, finely acuminate, striate in fruit.

*Hab.* Spreading over damp places all over Eastern Bengal to Chittagong *extending* up to Tenasserim in South Burma.

LIMNOPHILA CONFERTA Benth. (Pl. VII, Fig. 1.)

An erect or procumbent when old rather diffuse, very variable glabrous herb. Leaves all opposite, sessile or subpetioled, oblong or elliptic-oblong, obtuse crenate, serrate, punctate beneath, base narrowed or more or less stem clasping, nerves slender. Flowers axillary, solitary or in short axillary heads, spikes or cymes. Calyx glabrate, segments lanceolate, finely acuminate, striate in fruit. Capsule rather broadly elliptic obtuse.

*Hab.* Common in damp places all over Assam, Bengal extending from Chittagong down to Tenasserim in South Burma also spreading over throughout the Deccan and Ceylon.

LIMNOPHILA MICRANTHA Benth.

A small prostrate low herb with rather stout stem branching from the root. Leaves opposite, small sessile, crowded entire or sub-serrate, teeth few, thick, nerves very obscure, punctate Flowers axillary subsessile, red-purple. Calyx glabrous, lobes subulate, in fruit striate.

*Hab.* A distinct, dwarf rather stout branching weed of marshy places in Bengal and Assam passing from Chittagong down to Tenasserim in South Burma.

LIMNOPHILA GRATISSIMA Blume.

A stout erect weed simple or only branching upwards glabrous herb. Leaves opposite and ternately whorled ½ amplexicauled, linear oblong, subacute, serrulate, nerves few and faint. Inflorescence racemose, paniculately branched axillary and terminal, many flowered. Flowers solitary, axillary or whorled in racemes. Pedicels glandular. Calyx usually much shorter than the pedicels, glabrate. Calyx lobes lanceolate, acuminate, fruiting striate. Capsule oblong acute.

*Hab.* Common in water places of Chota Nagpur and Bengal and in the Deccan Peninsula also frequently met in Ceylon. Kurz reports its occurrence in Pegu, Burma.

LIMNOPHILA HYPERICIFOLIA Benth. (Pl. VII, Fig 2.)

A glabrous herb with stout erect, simple rarely branched stem. Leaves all opposite and entire, ½ amplexicauled, elliptic or ovate l oblong, obtuse, entire or slightly crenulate serrate towards tip, rather thick, minutely punctate beneath. Flowers large sessile, in the axils of opposite or alternate leafy bracts forming terminal and axillary sessile or peduncled spikes. Flowers rose-purple. Calyx lobes ovate acuminate, fruiting membranous not striate. Corolla twice as long as the calyx, purple. Capsule broadly elliptic.

*Hab.* Common in watery and marshy places in the eastern and the western Himalayas ascending in the Khasia mountains up to 4-5,000 feet also reported from the Nilgiri mountains and not unlikely in Burma as well.

LIMNOPHILA CANA Griff.

An extensively creeping low herb of marshes with submerged creeping stem sending up erect simple branches. Stem very stout hirsute. Leaves 3-6 ternately whorled, sessile upper elliptic or linear oblong, obtuse serrulate, 3-5 nerved gradually passing upwards into bracts which are almost imbricate, lower leaves pinnatifid. Flowers sessile or shortly pedicelled violet, crowded in terminal, rarely axillary, erect, leafy spikes with opposite or whorled bracts. Calyx lobes subulate.

*Hab.* In jheels of East Bengal.

LIMNOPHILA HETEROPHYLLA Benth. (Pl. VIII, Fig. 2.)

The plant is much larger in size than *L. sessiliflora*, annual with creeping roots and glabrous elongate slender stem Uppermost leaves usually opposite, small sessile, ½ amplexicauled, oblong crenulate, those next

below 4-6 in a whorl pinnatifid, the submerged long capillaceomultifid. Floral leaves towards the apex, opposite, small, entire or serrate. Flowers axillary, solitary, sessile or subsessile or the uppermost in short leafy spike, calyx lobes shortly acuminate. Fruiting calyx hemispheric membranous, not striate, lobes ovate shortly acuminate. Corolla-lobes somewhat bilabiate.

*Hab.* Common throughout India and Ceylon in wet places, ricefields and swamps.

LIMNOPHILA RACEMOSA Benth. (Pl. VIII, Fig. 3.)

A beautiful and curious annual with stout, erect, hirsute or glabrous stem. Leaves sessile, upper opposite or ternately whorled, ½ amplexicauled ovate or linear oblong, serulate, lower capillaceomultifid, minutely punctate beneath, nerves strong. Flowers large usually in terminal, erect racemes. Calyxlobes ovate acuminate, with slender points, fruiting membranous, not striate. Corolla bluish or purple, fragrant, Capsule almost globose.

*Hab.* A weed of pools and watery areas, ricefields and swamps submerged below, flowering in wet and cold season.

## Genus—HERPESTIS.

Glabrous herbs. Leaves often punctate, entire or toothed or submerged and multifid. Flowers axillary or racemose, yellow, blue or white. Pedicels bracteolate or not. Calyx 5 partite, upper sepals often very large, the two lateral innermost often very narrow. Corolla of 5 petals, tube cylindric. Upper lip outermost bilobed or notched, lower trilobed. Stamens 4, didynamous, included. Carpels connate in a 2 celled ovary. Style dilated at the top. Stigma entire or bilobed. Capsule 2 grooved. Fruit globose, ovoid.

HERPESTIS MONNIERIA H. B. & K. (Pl. VIII, Fig. 4.)

Quite glabrous rather succulent creeping herb. Leaves sessile ovate oblong or spathulate quite entire, nerves very obscure. Peduncles axillary, solitary, one flowered, usually longer than the leaves and the 2 awled bracteolate calyx. Upper sepal ovate. Corolla twice as long, lobes subequal. Anthers 2 cleft at the base, blue. Capsule included, ovate acute.

*Hab.* Common throughout India extending up to Burma in marshes, and the margins of lakes, jheels, etc., sometimes spreading over choked up tanks, etc. The plant is of considerable medicinal importance and is eaten by Indians. Flowering during the wet and cold seasons.

## Genus—DOPATRIUM.

Annual, delicate, glabrous herbs of marshes. Leaves few small, lower pairs small upper remote, minute. Flowers small violet, axillary, solitary. Calyx 5 lobed. Corolla of 5 petals, the upper outer lip short bifid the lower broad trilobed, spreading. Stamens 2, upper only perfect. Staminodes 2, minute. Ovary 2 celled; style short relative to corolla,

stigma bilamellate Fruit small globose or oblong loculicidal capsule. Valves placentiferous, seeds numerous, very small, tubercled

*Key to the species*

A Capsule linear oblong Bracts minute acuminate Calyx lobes acuminate ... *D nudicaule*

B Capsule globose

(1) Bracts minute obtuse Calyx lobes oblong obtuse ... *D junceum*

(2) Bracts minute obscure Calyx lobes very short obtuse ... *D lobelioides*

DOPATRIUM NUDICAULE Ham (Pl IX Fig 1)

A very slender low herb Stem simple or branched from the base Leaves radical, absent or very few, oblong obtuse, cauline few minute Flowers with calyx lobes acuminate Capsule linear oblong

DOPATRIUM JUNCEUM Ham

A low somewhat fleshy herb much branched at the base, the lower part swollen and spongy, the upper part slender Leaves few sessile, the lower oblong, elliptic or slightly obovate obtuse, the upper much smaller, remote, bract like, in distant pairs, nerves parallel Flowers axillary opposite in distant pairs rose coloured Pedicel filiform erect in fruit Calyx lobes oblong, obtuse Corolla pale, pinkish violet Ovary globose 1 celled with 2 parietal placentas Style stout Stigma broad, 2 lamellate Capsule globose 1 celled Seeds oblong, tuberculate

*Hab* Common throughout India in ricefields and swampy places

DOPATRIUM LOBELIOIDES Benth (Pl IX, Fig 2)

A low annual herb with stem fleshy below and very slender branches Leaves lower 2 4 pairs ovate oblong obtuse upper very few distant and small Nerves parallel very obscure Flowers subracemose in distant pairs, pedicels capillary, spreading in fruit Bracts obscure Calyx lobes very short obtuse Capsule globose

*Hab* Common in the South Deccan growing in wet places during the rainy season

Genus—BYTHOPHYTON

A slender submerged glabrous aquatic herb Leaves opposite subulate, lanceolate, quite entire Flowers axillary shortly pedicelled, bracteole absent Sepals 4, subulate-lanceolate Corolla much shorter than the calyx Petals subcylindric, membranous obscurely 2 lipped, 4 lobed Stamens 2, anterior perfect, included filaments short occasionally gibbous Anther cells parallel ovary ovoid, style short, curved; stigma subcapitate Capsules much shorter than the calyx lobes, broadly oblong, compressed, obtuse bivalved, valves bifid or bipartite Seeds many, narrowly oblong, reticulate

### BYTHOPHYTON INDICUM Hk.f.

Stems 2-3 in. high, loosely tufted, flaccid, erect, wholly submerged, terete. Leaves 3 nerved at the base. Corolla segments closed over the anthers. Stamens very variable.

*Hab.* Confined to the marshes in the valleys of the Khasia mountains ascending up to 4,000—5,000 feet. The flowers sometimes, when stranded in dried up marshy lands,. differ in their characters. The figure shown in the Hoaker's Journal of Botany, No. 9, 1857, p. 245, tab 7, shows the anthers as hairy. This is doubted but the figure showing hairy anthers is the basis of Plate XI, Figure 2.

## Family—LENTIBULARIACEÆ.

Low herbs usually of water or of wet places, often without roots. Leaves radical, rosulate when submerged, capillary-multifid, sometimes obsolete. Scape many flowered, raceme or spike. Flowers hermaphrodite, zygomorphic, pentamerous, purple, yellow or white. Sepals connate in 2-5 lobed calyx, often persistent. Petals shortly united in 2 lipped more or less spurred corolla, upper lip usually the smaller entire or emarginate, lower 3-5 lobed. Stamens 2, adnate to the base of the corolla, alternate with the lobes of the lower lip; filaments broad curved; anther cells 2, ovate, transversely confluent with 1 loculus. Ovary globbose, 1 celled, composed of 2 carpels; ovules many on a free basal placenta; style short; stigma unequally 2 lobed. Fruit a globose, 2-4 valved capsule breaking up irregularly, seeds minute, many, exalbuminous.

### Genus—UTRICULARIA.

Plants either floating or terrestrial growing in moist places or wet rocks. Leaves in floating species multifid with capillary segments; in erect or twinning terestrial species entire; frequently with minute bladders. Flowers on simple or branched scapes, racemes few or many flowered; pedicels bracteate occasionally with 2 bracteoles. Calyx lobes 2, sepals entire or nearly so, often enlarged in fruit. Corolla bilobed. Petals 5, tube with a straight or curved spur. Stamens 2, united at the base of the petals, alternating with the lobes of the lower lip, with broad filaments. Anthers ovate, 2-celled or confluent into 1-celled. Carpels connate in a globbose 1 celled ovary. Ovules many on a more or less free-central placenta, style short, stigma unequally bilobed. Fruit a globose 2-4 valved or irregularly rupturing capsule. Seeds many ellipsoid or obovoid, scrobiculate or glochidiate rarely reticulate or comose.

The Utricularia, the common bladder-wort. is generally a rootless submerged waterplant with finely divided leaves bearing on them bladders which are curious hollow structures with trapdoors. Small animals (Crustacea) enter these bladders by pushing the trapdoors which open from outside only; thus captured the animal organisms cannot escape and are supposed to be digested by the plant.

## *Key to the species.*

A Leaves submerged with or without capillary segments those divided into capillary segments mostly interspersed with bladders, stems floating

(1) Peduncles bearing almost near the middle a cluster of oblong vesicles

Flowers yellow . . . . . *U Stellaris*

Flowers white, with violet stripes . . . . . . . *U Stellaris var inflexa*

(2) Peduncles naked or with a few obscure scales, corolla yellow

(3) Peduncles rather stout, spur of corolla not longer than the lower lip

Flowers 3-8 . . . . . . *U flexuosa*

(4) Peduncles slender, spur of corolla somewhat longer than the lower lip

Flowers 1-3 . . *U exoleta*

B. Leaves at the base of scapes linear spathulate, often falling off before flowering, stem rooted in mud, if growing in running water, and at times emitting a few capillary leaves with bladders, fruit not globose, seeds smooth

I Scales of the scape and bracts attached by their bases, calyx lobes equal or nearly so

(1) Flowers purple or blue

(*a*) Scapes glabrous, flowers pedicelled —

Scapes suberect, calyx lobes acute *U reticulata*

Scapes very slender, twining, calyx lobes obtuse . . . . . . *U scandens*

(*b*) Scapes hairy, flowers subsessile, calyx lobes orbicular . . . . . . *U hirta*

(2) Flowers yellow.

(*a*) Scapes erect, glabrous pedicels finally recurved in fruit calyx lobes obtuse . *U bifida*

(*b*) Scapes very slender, often twining, pedicels suberect in fruit, calyx lobes ovate acute . *U Wallichiana*

II Scales of the scape and bracts produced backwards below their point of insertion

Flowers blue or sometimes whitish . . . . *U racemosa*

### UTRICULARIA STELLARIS Linn. f. (Pl. IX, Fig. 3.)

A submerged aquatic herb. Stolons filiform slender, not much branched. Leaves all submerged often in whorls of 4, pinnately cut into numerous capillary slender pectinate segments, each pinna usually provided near the base with a small globular ovoid bladder with a truncate mouth. Peduncles erect, glabrous, kept suspended in the water by means of a whorl of oblong vesicles about their middle. Flowers pedicellate, yellow, in slender erect few, 12 flowered racemes. Floats in whorls of 4-8 attached ½ inch below the lowest flower, broadly ellipsoid or ovoid, reticulately veined with a tuft of reduced filiform pinnæ at the apex: bracts long. Pedicels thickened usually deflexed in fruit. Calyx 2 partite, sepals subequal, suborbicular, veined, enlarged in fruit. Corolla yellow, upper lip rotund, yellow, corolla spur shorter than the lower lip more or less curved, subcylindric, stout, blunt appressed to the lower

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### Genus—UTRICULARIA.

Plants either floating or terrestrial growing in moist places or wet rocks. Leaves in floating species multifid with capillary segments; in erect or twinning terestrial species entire; frequently with minute bladders. Flowers on simple or branched scapes, racemes few or many flowered; pedicels bracteate occasionally with 2 bracteoles. Calyx lobes 2, sepals entire or nearly so, often enlarged in fruit. Corolla bilobed. Petals 5, tube with a straight or curved spur. Stamens 2, united at the base of the petals, alternating with the lobes of the lower lip, with broad filaments. Anthers ovate, 2-celled or confluent into 1-celled. Carpels connate in a globbose 1 celled ovary. Ovules many on a more or less free-central placenta, style short, stigma unequally bilobed. Fruit a globose 2-4 valved or irregularly rupturing capsule. Seeds many ellipsoid or obovoid, scrobiculate or glochidiate rarely reticulate or comose.

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*Key to the species*

A Leaves submerged with or without capillary segments those divided into capillary segments mostly interspersed with bladders stems floating

(1) Peduncles bearing almost near the middle a cluster of oblong vesicles

Flowers yellow — *U Stellaris*

Flowers white with violet stripes — *U Stellaris var inflexa*

(2) Peduncles naked or with a few obscure scales corolla yellow

(3) Peduncles rather stout spur of corolla not longer than the lower lip

Flowers 3 8 — *U flexuosa*

(4) Peduncles slender spur of corolla somewhat longer than the lower lip

Flowers 1 3 — *U exoleta*

B Leaves at the base of scapes linear spathulate often falling off before flowering stem rooted in mud if growing in running water and at times emitting a few capillary leaves with bladders fruit not globose seeds smooth

I Scales of the scape and bracts attached by their bases calyx lobes equal or nearly so

(1) Flowers purple or blue

(a) Scapes glabrous flowers pedicelled —

Scapes suberect calyx lobes acute — *U reticulata*

Scapes very slender twining calyx lobes obtuse — *U scandens*

(b) Scapes hairy flowers subsessile calyx lobes orbicular — *U hirta*

(2) Flowers yellow

(a) Scapes erect glabrous pedicels finally recurved in fruit calyx lobes obtuse — *U bifida*

(b) Scapes very slender often twining pedicels suberect in fruit calyx lobes ovate acute — *U Wallichiana*

II Scales of the scape and bracts produced backwards below their point of insertion

Flowers blue or sometimes whitish — *U racemosa*

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lip. Capsule globose. Seeds small discoid, prismatic in cross section, 4-6 angled, concavo-convex by the inflexion of the entire thin slightly winged margin.

*Hab.* Common in ponds and ditches, freshwater swamps and rice-fields. Flowering during the rains, fruiting later.

Var. inflexa. Corolla white with violet stripes, and the spur frequently as pubescent and as little curved as in the typical species.

UTRICULARIA FLEXUOSA Vahl.

A submerged waterplant, floating in large masses a little below the surface of the water, generally resembling *U. stellaris,* but rather larger in all its parts, often very long, stout and much branches. Leaves usually in whorls of 4, pinnately divided into numerous filiform pectinate segments, each pinna usually with a nearly globose bladder near its base. Flowers yellow, pedicelled, few, in straight racemes. Peduncles long, naked or with a few small scales, without a whorl of floats below the flowers, but the cluster of leaves at the base of the peduncles often with rachis much inflated (perhaps acting as a float) and the segments very short. Bracts ovate small; pedicels rather long, at first erect, afterwards deflexed. Calyx rather long; sepals ovate-oblong, obtuse or subacute, veined, patent, hardly as long as the capsule, but somewhat enlarged in fruit; corolla spur nearly as long as the lower lip, conical acute. Fruit globose beaked with a thick persistent style. Seeds discoid, irregularly 4-6 angled, concavo-convex by the inflexion of the thin scarcely winged margin.

*Hab.* Common throughout India in lakes, jheels, tanks, pools, etc., and in rice-swamps.

UTRICULARIA EXOLETA Br. (Pl. XX. Fig. 1.)

An aquatic herb floating in water or growing on liquid muddy areas. Branches more or less fascicled. Leaves multipinnate up to 3 inches long, segments generally capillary, bearing bladders. Bladders obliquely ovoid, the mouth rather truncate at the apex, furnished with slender long branched hairs. Peduncles slender, 1-3 flowered, minutely bracteate near the middle. Flowers small yellow, calyx consisting of subequal, elliptic obtuse, membraneous sepals scarcely enlarged in fruit. Corolla yellow with orange streaks, with ovate suborbicular entire upper lip and long subquadrate more or less bilobed lower lip. Spur conical, obtuse. Capsule globose. distinctly exceeding the sepals, seeds small orbicular flat, surrounded by more or less crenulate corky wing.

*Hab.* Occurring throughout India, but not very common. Flowering generally in February.

UTRICULARIA RETICULATA Smith. (Pl. VII, Fig. 3.)

A small glabrous herb in marshy places. Leaves narrowly linear-oblong, obtuse, usually deciduous before flowering and often furnished with many small bladders. Scapes slender, twining bearing flowers only half the length with 2 or 3 distant bracts. Pedicels with filiform

bracteoles Flowers bluish purple large rather distantly placed in the raceme Calyx with sepals much enlarged and decurrent on the pedicel in fruit Corolla large up to ¾ inch or more across lower lip sub orbicular entire bullate in the centre with a white spot near the base Spur conic nearly straight Capsules ellipsoid enclosed by greatly enlarged sepals Seeds ovoid or subrhomboid scrobiculate

*Hab* Common in the Deccan Peninsula and Bihar and Orissa in the ricefield and marshy lands flowering in October

## UTRICULARIA SCANDENS Benj

A slender twining herb in marshy areas scapes exceedingly slender twining on others Pedicels scattered in the racemes Calyx lobes in fruit obtuse Corolla with lower lip blue Seeds minute obovoid, scrobiculate

*Hab* Occurring near Madras the Madura Hills very rare in Bengal but reported by Kurz from this province

## UTRICULARIA HIRTA Klein

A small hairy herb in marshy places scapes erect slender minutely densely hairy bracts not produced backwards below the point of insertion Flowers subsessile calyx lobes orbicular in fruit lower lip of corolla blue spur curved Capsule globose Seeds minute ovoid obscurely scrobiculate

*Hab* Occurring in the Deccan Peninsula but also found by Clarke in Chota Nagpur at an elevation of 2 000 feet and by Griffith in the Khasia Mountains at an altitude of 3 000 5 000 feet

## UTRICULARIA BIFIDA Linn (Pl XI Fig 4)

A glabrous small herb of marshy places Scapes erect glabrous many flowered Pedicels finally recurved Flowers yellow Calyx lobes ovate obtuse in fruit spur of corolla curved Seeds obovoid more or less wrinkled owing to the presence of lax scrobiculate testa

*Hab* Occurring in most of the provinces throughout India

## UTRICULARIA WALLICHIANA Wight (Pl VII Fig 4)

A small usually twining herb of marshy places Stems twining very slender Flowers yellow Pedicels suberect in fruit Calyx lobes ovate acute in fruit Spur nearly as long as the lower lip of corolla Seeds ellipsoid scrobiculate without papillae or glochidia

*Hab* Occurring in the hills of the South Deccan Peninsula and Ceylon also reported from Bihar and Chota Nagpur

## UTRICULARIA RACEMOSA Wall (Pl X Fig 1)

A small glabrous herb of marshy lands Scapes rather long (6 16 inches long) with scales and bracts produced backwards below their point of insertion Flowers many blue subsessile frequently subfasciculate

### *Key to the species.*

| | |
|---|---|
| Terminal spikes with 4 rows of bracts imbricated in fruits | *C uliginosa* |
| Basal leaves much divided whorled or axillary spikes . | *C triflora* |

### CARDANTHERA ULIGINOSA Ham.

Erect or decumbent annual herb branching from the base. Stem pubescent towards the upper part. Leaves 1 × ⅓ inch subsessile, oblong oblanceolate, entire or crenate, glabrous or subpubescent. Bracts elliptic or round ovate or cordate. Spikes 1-3 inches scarcely interrupted at the base even in fruit Sepals from 1/5 inch linear, pubescent. Corolla larger than sepals. Fruit from 1/5 inch, minutely hairy upwards

*Hab.* In swamps and wet ricefields Common in North Bengal Duars up to Sikkim and S Madras

### CARDANTHERA TRIFLORA Ham (Pl XVI, Fig 1 )

Decumbent annual herb rooting at the base. Leaves ovate or round crenate-serrate, lower leaves often pinnatifid submerged leaves large finely segmented, membranous, upper leaves ½ to 1 inch in diameter, tip rounded base cuneate or subpetioled, more or less closely sharply toothed. Flowers in axillary whorls. Bracts about ½ inch, obovate, sometimes toothed, bracteoles ½ inch, oblong, sepals equalling the bracts linear, one longer than the others very acute Corolla ⅓ to ½ inch. Fruit ¼ to ⅓ inch long, pubescent.

*Hab.* Very common along the margin of water in Bengal and extending up to Assam, Pegu and Singapore.

## Genus—HYGROPHILA.

Low herbs, sometimes spinescent. Leaves opposite, lanceolate or obovate, entire Flowers sessile, in terminal heads or axillary whorls bracts elliptic or lanceolate, bracteoles linear or lanceolate. Calyx tubular, usually 5 fid rarely 4 partite, lobes lanceolate linear. Corolla deeply bilabiate, bluish purple, *tube ventricose towards the apex. Stamens* 4, didynamous, posterior pair similar to the anterior or smaller or rudimentary; filaments glabrous, anthers oblong Ovary oblong with hairy tip; style rather long hairy; stigma simple linear. Capsule linear or narrowly oblong, bearing seeds from the base, seeds varying in number from 2-8 to 100, ovoid, compressed, elastic with hygroscopic white hairs, retinacula hardened, acute curved.

### *Key to the species.*

| | | | |
|---|---|---|---|
| Plants unarmed | Calyx 5 toothed | Seeds more than 20 . | *H polysperma* |
| Plants armed | Calyx 4 toothed | Seeds 4-8 . . . | *H spinosa* |

### HYGROPHILA POLYSPERMA T. Anders.

An annual, rather creeping herb with branches often rooting at the base Leaves ½ to 1½ inches subsessile, more or less tapering towards the base, oblong, or obovate nearly entire, almost glabrous or puberulous Flowers in terminal dense oblong or linear somewhat pubescent spikes 1-6

inches long. Bracts elliptic oblong, imbricate; bracteoles lanceolate or linear nearly as long as sepals. Calyx of 5 sepals linear, hairy with ciliate margins, about ¼ inch long. Corolla 2 lipped, slender, pale blue or white about ½ inch long. Stamens 2 fertile, upper stamens reduced to teeth, anthers oblong almost equal, slightly divaricate at the base. Ovary hairy at the apex. Fruits ¼ to ½ inch, valves recurved after dehiscence. Seeds more than 20, orbicular on hard curved retinacula.

*Hab.* A common weed of wet places throughout India.

### HYGROPHILA SPINOSA T. Anders. (Pl. X, Fig. 2.)

A spinous erect hairy herb with jointed undivided fascicled stems. Leaves spinous, lanceolate, or linear lanceolate, verticelled, with white hairs, whorls axillary dense with straight stout spines, ½ to 1½ inches long. Bracts ½ to 1 inch lanceolate bristly bracteoles a little smaller, narrower. Flowers in whorls, many sessile, large of a bright blue or sometimes rose colour. Calyx of 4 sepals, upper larger lower obtuse, emarginate. Corolla 1 inch long, 2 lipped, lips nearly equal, upper biparted with the divisions emarginate, the under ones three parted with the divisions emarginate. Anthers subequal, oblong, sagittate. Stigma subulate, involute. Fruits ½ inch long, shorter than the calyx, linear, oblong 4-8 seeded from the base.

*Hab.* Common in wet places all over India.

## Family—AMARANTACEÆ.

Herbs rarely undershrubs. Leaves opposite or alternate, exstipulate. Flowers hermaphrodite in terminal spikes or in axillary clusters. Bracts membranous. Perianth-segments scarious 4-5, rigid, ribbed, subulate-lanceolate. Stamens 1-5, connate below or united with intervening membranous staminodes; anthers 1 to 2 celled. Ovary 1-celled. Styles 1-3, filiform. Stigma capitellate. Fruit an ovoid utricle. Seed inverse, erect, orbicular, compressed, testa crustaceous.

## Genus—ALTERNANTHERA.

Usually decumbent or prostrate herb. Leaves opposite, entire. Flowers hermaphrodite. Perianth segments 5, sepaline, unequal, stamens 2-5. Ovary orbicular. Stigma subsessile. Ovule pendulous. Utricle compressed, ovoid, margins often winged.

### ALTERNANTHERA SESSILIS Br. (Pl. IX, Fig. 4.)

A prostrate annual or biennial herb with fibrous roots. Branches straggling, creeping, glabrous, the ultimate with two lines of hairs. Nodes villous. Leaves opposite ½ to 3 inches, in wet places longer and broader, linear oblong lanceolate, elliptic obtuse or subacute, entire, nearly smooth, sometimes rather fleshy, occasionally obscurely denticulate. Clusters of flowers ¼ to ½ inch long, white, axillary, hardly glistening. Perianths 5, rigid, glabrous acute. Anthers 2-3. Utricle usually broader than the perianth, very broadly obcordate, wings often corky.

## Family—CHENOPODIACEÆ

Annual or perennial occasionally fleshy herbs or undershrubs Leaves alternate (rarely opposite) exstipulate, simple, usually entire flat or sometimes cylindric, membranous or fleshy. Flowers small usually pale green, hermaphrodite or unisexual, usually regular often dimorphic. Bracts 1 or absent bracteoles 2 or absent Perianth simple, sepaline, segments 3-5, free or connate imbricate in buds Stamens 5 opposite the perianth segments, filaments with intervening staminodes, anthers bilocular. Ovary globose or 1-celled, free or enclosed in the perianth base, style terminal, stigma capitate, 2-3-lobed, or styles 2-3, or stigmas 2 5, free or slightly united sessile. Fruit usually a utricle enclosed in the often enlarged fleshy calyx Seeds horizontal or vertical, testa crustaceous, coriaceous or membranous

### *Key to the genera*

Stems leafy not jointed

Leaves fleshy semiterete flowers usually 2 sexual perianth 5 lobed sepals not winged utricle enclosed in the simply enlarged perianth embryo spiral — *Suaeda*

Leaves membranous flat flowers dissimilar monœcious or polygamous florets ebracteolate 3 5 lobed or parted florets without perianth 2 free or connate bracteolate dilated into 2 valved covering for the utricle — *Atriplex*

Stems fleshy usually jointed

Leaves absent flowers hermaphrodite Flowers 2 6 together in the axils of the scales of sessile cone like spikes perianth ovoid or pyramidal mouth narrowed 3-4 fid embryo horseshoe shaped, albumen fleshy — *Arthrocnemum*

Flowers 3 nate sunk in superposed cavities in successive joints perianth obpyramidal mouth wide truncate or with 3 4 minute teeth, embryo conduplicate albumen none — *Salicornia*

## Genus—SUÆDA

Low herb or undershrub growing in saline marshes Leaves fleshy, ternate, terete rarely flattish Flowers minute, axillary usually hermaphrodite, rarely by abortion unisexual bracteate or 2 bracteolate Perianth short, globose or urceolate, 5 lobed or 5 partite, segments equal or unequal, simple gibbous or almost winged Stamens 5 short, anthers rather large Ovary ovoid or orbicular with a wide base adnate to the perianth, rounded or truncate at the apex Style absent; stigma 2-5 minute, subulate, recurved, papillose throughout. Fruit a small membranous or spongy utricle included in the perianth Seeds, erect horizontal or oblique, testa crustaceous or coriaceous

### *Key to the species*

Perennials diffusely branched leaves glaucous green flowers in dense many flowered clusters bracteoles with pectinate margins styles 3 seeds erect — *S nudiflora*

Annual erect herb, styles 2 seeds usually horizontal . *S maritima*

### SUÆDA NUDIFLORA Moq.

Perennial herb or undershrub with diffusely branched woody stem, spreading close upon the ground and often striking root, the extremities of ramous branches ascending, young parts smooth and coloured reddish or yellowish. Leaves numerous soon falling, ¼ to ½ inch long, rigid, elliptic oblong or semiterete, obtuse, ellipsoid or the lower linear obovate-oblong, glabrous, glaucous green. Bracts hyaline toothed often forming persistent stellate tufts at the axils of the leaves after the fruiting perianths have fallen away. 'Flowers on many flowered confluent globose dense leafless spikes which are towards the upper part, hermaphrodite axillary. Perianth obovoid; segments oblong obtuse. Styles 3, utricle ovoid. Seeds erect, lenticular, smooth, shining, testa crustaceous black.

*Hab.* Common along the sea-coast of Bengal, Bombay, the Deccan and Ceylon, forming one of the predominant species in Salt-marshes.

### SUÆDA MARITIMA Dumort. (Pl. XVII, Fig. 1.)

An annual or perennial glaucous green or yellowish green or reddish green erect herb sometimes branched from the base. Leaves linear or *filiform* semiterete. Flowers *minute* in small clusters on slender spikes. Perianth 5. Stamens shorter than the calyx, anthers globular two lobed, fruiting perianth depressed, lobes rounded covering the utricle, styles long slender. Seed usually horizontal, somewhat beaked.

*Hab.* In salt-marshes of Bengal, Bombay, the Deccan and Ceylon. Flowering nearly throughout the year. Leaves are said to be edible and are eaten during scarcity.

### Genus—ATRIPLEX.

Herbs or shrubs usually mealy. Leaves alternate or rarely opposite. Flowers monœcious or diœcious clustered in simple or panicled spikes. Bracts and bracteoles absent in male flowers, absent in female flowers 2, flat, accrescent, dilated in fruit, and forming a 2 valved covering to the fruit. Male flowers. Perianth 3-5 lobed sepaline, segments obtuse or oblong. Stamens 3-5 inserted at the base of the perianth, anthers didymous. Ovary rudimentary or absent rarely perfect. Female flowers. Perianth absent, rarely like that of the male. Disc absent. Ovary ovoid or depressed-globose; stigmas 2, subulate or filiform, connate below. Fruit a membranous utricle, enclosed in the enlarged bracteoles. Seed erect or inverted rarely horizontal.

### ATRIPLEX STOCKSII Boiss.

Perennial erect or prostrate white woody undershrub or herb. Leaves ½ to 1 inch, rather succulent, oblong elliptic or suborbicular, shortly petioled. Male flowers in axillary clusters, on short rather leafy spikes. Fruiting bracteoles of female flowers reaching ⅜ inch in diameter, orbicular or broadly ovate, labyrinthically veined, cuneate at the base, swollen and fleshy above the utricle. Seeds orbicular, compressed, pale brown, smooth.

*Hab.* Common in Salt-marshes near the sea in Karachi. Flowering December-January.

## Genus—ARTHROCNEMUM

Branching jointed leafless succulent herbs or shrubs. Leaves absent. Flowers minute, hermaphrodite, 2-3 together in axils of the scales, forming sessile cone-like spikes, bracteoles 2. Perianth sepaline ventricose, simple or ovoid or angled Stamen 1; anther oblong. Ovary ovoid tapering to the tip Stigmas 2, subulate. Fruit utricle ovoid compressed with hardened pericarp enclosed in the swollen perianth Seed erect, ovoid, compressed, testa membranous, smooth

### ARTHROCNEMUM INDICUM Moq.

Perennial diffused or prostrate woody suffruticose herb or shrub. Flowers in cylindric blunt spikes ½ to ¾ inch long, bracteoles spongy Fruiting perianths 3 together, shorter than the cupshaped joints, closely appressed, laterally compressed, spongy, gibbous towards the apex of the axis of the spike, flat towards the cup, top broadly truncate with a minute hole for the protrusion of the stigmas Anthers large oblong ovoid. Utricle united to the perianth, ovoid compressed Seed erect, orbicular, testa membranous

*Hab.* Common in Salt-marshes of Bengal (Sundribun area) Bombay and Northern Circars. Flowering in December.

## Genus—SALICORNIA

Branched, leafless, jointed herbs or shrubs *Flowers very small* bisexual, ternate in the axils of scaly bracts, sunk in superposed and decussately opposite cavities of the joints of cone like spikes Bracteoles 2 Perianth sepaline, 3-4-toothed, obpyramidal Stamen 1-2, anther oblong. Ovary ovoid narrowed to the tip, stigmas 2, subulate Fruit an ovoid compressed utricle with membranous pericarp, enclosed in the spongy perianth Seed erect compressed, testa hispid with hooked hairs.

### SALICORNIA BRACHIATA Roxb (Pl X, Fig 4)

Perennial erect herbs or shrubs with numerous decussate slender branches which are bifid and divided and sub-divided in the same manner and whose extremities form the succulent cylindric jointed spikes. Flowers conspicuous 1-3 inches long, three on each side of each joint, opposite. Perianth a flasklike fleshy substance with a longitudinal slit for the stamen and style, persisting up to the ripening of the seed Stamens 1, anther sagittate Stigma bifid, utricle membranous ovoid, subacute. Seed pale brown, hispid, with white hairs. Testa thinly coriaceous

*Hab.* Bengal (Sundribun) in Salt-marshes between the zones of tidal marks, also in Western India and Ceylon *Flowering all the year round*

## Family—POLYGONACEÆ.

Herbs or shrubs. Leaves alternate, rarely opposite, with scarious or membranous characteristic stipules (Ochrea) clasping the stem above the leafbase. Flowers regular, hermaphrodite, solitary or fascicled within

the bract, fascicles axillary, racemose or cymose, bracts cupular, ochreate or involucrate. Perianth simple, sepaline, 3-6, free or connate, persistent, imbricate in bud. Stamens 5-8, rarely more or fewer, opposite the perianth segments; anthers 2 celled, disc, annular, glandular or absent. Ovary 1-celled, compressed, 3-4 gonous; styles 3-4, stigmas capitate, peltate or fimbriate. Fruit a small trigonous nut, enclosed in perianth. Seed erect, testa membranous.

### *Key to the genera.*

Perianth 3-5 cleft. Stamens 1-8, rarely more.
Stamens 8 or fewer, capitellate . . . . . . . *Polygonum.*
Perianth 6 cleft 3 inner enlarged in fruit. Stamens 9 rarely 6, stigmas fimbriate, peltate or horseshoe shaped . . *Rumex.*

## Genus—POLYGONUM.

Herbs occasionally undershrubs. Leaves alternate, entire, rarely lobed; stipules tubular, membranous. Flowers small or minute, in axillary or terminal sessile clusters or in spiciform, capitate or panicled racemes; pedicel short, usually jointed under the perianth; bracts and bracteoles membranous, ochreate. Perianth green or coloured, 4-5, rarely 3 cleft. Stamens 5-8, rarely 1-4, perigynous; filaments filiform, usually dilated below or alternate with the lobes of an annular or glandular disc; anther 2-celled. Ovary compressed or trigonous; styles 2 or 3, free or slightly united below; stigmas capitate. Fruit a compressed 3 gonous nutlet with obtuse or acute angles, covered or nearly covered by persistent perianth, usually with hard shining or dull pericarp.

### *Key to the species.*

Nutlets orbicular biconvex :
(*a*) Bracts closely hairy or strigose :
Leaves ovate, petioles long . . . . . . *P. Orientale.*
Leaves lanceolate, petioles short :
Limb of ochrea truncate ciliate erect . . . . *P. tomentosum.*
Limb of ochrea ciliate, scabrid, spreading or recurved . *P. limbatum.*
(*b*) Bracts densely woolly . . . . . . . *P. lanigerum.*
(*c*) Bracts ciliate, perianth without glands; limb of ochrea shortly ciliate . . . . . . . *P. minus.*
Nutlets trigonous :
(*a*) Bracts glabrous, leaves rounded or cordate at the base or if tapering the marginal cilia of the ochrea not longer than the tube . . . . . . . *P. serrulatum.*
(*b*) Bracts always glandular, ochrea with cilia at least half as long as the tube . . . . . . *P. flaccidum.*

## POLYGONUM ORIENTALE Linn. (Pl. XVIII, Fig. 2.)

Annual suberect branching hairy herb or undershrub, ends of the branches when wet become thickly glutinous. Leaves 6-9 × 2-5 inches long petioled, ovate or ovate cordate, acuminate, covered with soft grey hairs, with petioles inserted into the stipules. Stipules short, strigose, ciliate, striated, truncated, mouth membranous or herbaceous, spreading, open or recurved, sometimes closely embracing the stem. Racemes

3-5 inches, cylindric laxly panicled, long peduncled, crowded with white flowers Bracts 3-6 flowered, crowded, strigosely tomentose and ciliate. Flowers large, white, red or green Stamens 7 8, included Styles bifid, united below, stigmas globular Nuts orbicular, flattened, with rounded margins and rather concave faces, black, shining, pericarp very thick

*Hab* In ditches and swamps and flooded areas and wet places from Assam and Sylhet westwards up to Jammu ascending 5,000 feet in the Himalayas Flowering in the beginning of rainy season This species occasionally develops a pure association in shallow freshwater jheels and lakes as in the Loktak Lake, Manipur, forming one of the predominant species of the vegetation of the floating islands of the lake (Photo V)

POLYGONUM TOMENTOSUM Willd (Pl XIX Fig 2)

Annual rather stout, prostrate, pubescent or glabrous herb or undershrub Leaves 4-8 inches × 1-1½ inch, shortly petioled, lanceolate finely acuminate, silky pubescent on both sides, rarely glabrate, base tapering, stipules ½ to 1 inch, membranous, strigose, mouth truncate, erect, cilia with rigid bristles Flowers in paniculate spike-like racemes 1½ inch to 3 inches long peduncles strigosely hairy, bracts nearly as long as broad, 6 8 flowered, orbicular, hispid, ciliate with long bristles, bracteoles small lanceolate membranous Flowers large white Perianth segments rather deeply divided 5 ovate oblong obtuse Stamens 7 8 Styles 2 recurved Nuts orbicular compressed with rounded margins and convex faces pericarp very thick crustaceous black shining

*Hab* In ditches and swamps from Bengal, Assam and Cachar extending southwards to Malacca, and from Bombay to Malabar to Ceylon

POLYGONUM LIMBATUM Meissn

Annual herb, stout, erect or prostrate below with simple pubescent or glabrous stem Leaves 4 8 inches × 1-1½ inch shortly petioled lanceolate, acuminate, scaberulous on both surfaces, base tapering, stipules cylindric, strigose mouth truncated with a spreading or recurved, *herbaceous, scabrid, ciliate limb Flowers in short, erect, paniculate* racemes, peduncles stout, strigose, bracts crowded, hispid

*Hab* In ditches, swamps, jheels, of Bengal, Upper Gangetic Plain, Garhwal

POLYGONUM LANIGERUM R Br (Pl XII Fig 2)

Annual or perennial procumbent herb with herbaceous jointed stems clothed with snow white cottony tomentum, rooting at the nodes, internally of a deep red colour, particularly at the joints Leaves linear lanceolate, short petioled or sessile, entire, acuminate woolly underneath stipules nearly as long as the joints, truncate, membranous, striated, woolly, having their mouths lacerated but not bearded or ciliated Racemes terminal, erect, cottony peduncles, crowded with numerous white flowers Bracts many flowered, small crowded glabrous or tomentose, eciliate obtuse or acute Perianth eglandular, 4 parted small, red or white Stamens 6 Style 2 cleft Nut round flat, smooth, shining, black or brown coloured

*Hab.* In ditches or swamps of Bengal and along the lower Himalayas. Flowering during the rains.

### POLYGONUM GLABRUM Willd. (Pl. XII, Fig. 1.)

Annual, suberect or procumbent herb or undershrub with stems usually reddish below, younger parts usually green, polished, with a dark reddish brown ring at each node. Leaves 3-9 × ⅝-1¼ inches, lanceolate or linear lanceolate, acuminate, tapering at both ends, entire, smooth on both sides; petioles of young leaves usually red. Stipules not ciliate, sheathing, lobed, smooth, adhering firmly to the stem, mouth a little ragged. Racemes slender and smooth, panicled. Bracts truncate, few flowered, ovate, obtuse, with membranous not ciliate margins. Flowers numerous, Perianth white or rose-coloured, 3-4 inches each set of bracts, appearing in succession. Stamens 6-8. Style 3 cleft, twice as long as the stamens. Nutlets broadly ovoid or suborbicular; compressed, biconvex, black shining.

*Hab.* In ditches and swamps of Assam, Bengal, westwards to the Indus and Sind and southwards to Burma even ascending the Himalayas up to 6,000 feet in Garhwal. Common in Ceylon too.

### POLYGONUM MINUS Huds.

Annual slender, creeping much branched low herb. Leaves sessile, linear or oblong lanceolate, subacute, usually under 2 inches, glabrous or puberulous beneath or minutely strigose on the midrib beneath. Stipules sparsely strigose, truncate, ciliate, cilia much shorter than the tube, ¼-½ inch, with stiff closely appressed bristles. Racemes erect filiform ½ to 1 inch. Bracts close, rarely interrupted, glabrous, ciliate. Flowers minute. Perianth eglandular. Nut polished, orbicular.

*Hab.* In ditches and swamps throughout the hotter parts of India, from Assam and Chittagong to Kashmir and southwards to Travancore, ascending in the Himalayas up to 6,000 feet but in Ceylon ascending to 4,000 feet only.

### POLYGONUM SERRULATUM Lagasc. (Pl. XIX, Fig. 1.)

Annual, rather stout. smooth, often reddish herbs with slender, straggling, jointed, round branches rooting at the nodes. Leaves 2-5 inches × ⅜ to ⅝ inch subsessile, lanceolate, or linear or elliptic oblong, acuminate or acute, glabrous or sparsely hairy beneath, base rounded cordate or acute. Stipules 1½ inch long, strigose, mouths truncate with long stiff bristles which are nearly as long as the tube. Flowers white, crowded in paniculate, slender, erect, ½ to 1½ inches long racemes; peduncles glabrous. Bracts membranous, ciliate with long hair, margins somewhat rose-coloured. Perianth eglandular white, segments ovate. Stamens 5-8, style ½ three cleft. Nutlets three sided, smooth, polished, of a rather dark brown colour.

*Hab.* In ditches and marshes of the plains and low hills of Northern India from Assam and Bengal to the Indus ascending to 4,000 feet in the Himalayas from Kumaon westwards. Flowering during the rains.

### POLYGONUM FLACCIDUM Meisn

Annual, branching, flaccid, often biennial, if not perennial herb. Leaves 2-6 inches long, petioled, lanceolate or elliptic lanceolate, acuminate, entire, smooth or with the exception of the midrib and the nerves beneath or hispidly or strigosely hairy on both the surfaces or underneath only, more or less glandular Stipules usually very strigose with stiff appressed hair, mouth crowned with cilia, as long as the tube Racemes terminal, long filiform subpaniculate sometimes 6 inches long, with fascicles of flowers rather remote Bracts usually distant, obliquely truncated, glabrous, mouth ciliate glandular or not Perianth bright pink, profusely glandular stamens 8, styles 3 Nuts three-sided, rarely compressed, granulate, black

*Hab* Common in ditches, swamps and wet places throughout India, ascending the Himalayas to 4,000 feet and extending up to Ceylon and Malacca Flowering during the wet season

## Genus—RUMEX

Perennial or annual herbs, rarely shrubs Leaves radical or cauline, alternate, entire or toothed, stipules hyaline, ochreate often disappearing with age Flowers hermaphrodite or monœcious, in axillary clusters or in fascicles, arranged in simple or panicled racemes Pedicels jointed Bracts ochreate, bracteoles absent Perianth sepaline, segments 6 rarely 4, the inner accrescent, entire or toothed, midrib or disc often enlarged or tubercled Stamens 6, anthers oblong Ovary trigonous, styles 3, stigma fimbriate Fruit a small nut, enclosed in the usually enlarged inner perianth segments, angles acute Seed erect

### RUMEX MARITIMUS Linn (Pl XIX, Fig 3)

Annual erect herb, 1 4 feet high with stems furrowed smooth. Leaves alternate, 3-10 inches petioled, base always narrowed into the petiole, lanceolate entire superior floral leaves linear petioles with a trifling membranous vagina at the base Inflorescence with whorls of many drooping pedicelled flowers panicled, leafy to the top Valves rhombic, or oblong, ovate with a lanceolate tip all with an oblong tubercle unarmed or with 2 3 long needle like spines Fruiting perianths all unarmed or on the same plant some armed and some unarmed, yellow-brown when ripe tubercle callous grained on the outside, with a narrow sometime reticulate margin spine sometimes four times as long as the valve tips straight or slightly hooked Style short filiform stigmas pencil shaped, seeds large, oblong ovate and with a granulous surface

*Hab* In marshes of Bengal Sylhet, Assam and Cachar.

## Family—PODOSTEMONACEÆ

Annual or perennial submerged aquatic herbs in rushing water and torrential hill streams attached to rocks and stones At the base of the primary axes buds out a green thallus and in Podostemon it is more or less of a filamentous nature creeping on the rocks and attached by means of

hairs or projections termed haptera. Leaves simple alternate, much divided, (till the latter part of the rains). With the fall of the water flowers are formed. Fruits are developed later on which burst and discharge seeds. These seeds rest on the rocks and with the advent of the rains under favourable conditions develop into individual plant. The morphology and the life history of the different species of this family is highly complicated and is an interesting study which has been greatly advanced by Willis in his important monograph entitled " Studies in the morphology and ecology of the Podostemaceae of Ceylon in India " published in Ann. Roy. Bot. Gard. Peradeniya, Vol. I, pp. 267-465, Pl. 34, 1902.

The family is characterised by simple, regular or irregular flowers, unisexual, rarely diœcious, naked or enclosed in a spathe, actinomorphic or zygomorphic. Perianth when present 3 lobed; lobes imbricate, macrescent. Stamens definite or not, in regular flowers 3, alternate with the perianth segments; in zygomorphic flowers usually 2, monodelphous on the lower side of the flower, the common stalk usually much exceeding the partial filaments; staminodes in *zygomorphic* flowers usually 2; filaments flat; anthers introrse, 1-2 or many, 2-celled. Ovary free, sessile, or stalked, smooth or ribbed, 1-3-celled with thick axile placenta and delicate septa. Styles 2-3, or one and columnar, stigma one capitate or 2-3, simple toothed or laciniate, fruit usually pedicellate, 1-3-celled, ribbed or smooth, septicidal or septifragal; valves 2-3. Seeds numerous minute; testa mucilaginous. Of the many species Podostemon Wallichii of the Khasia Hills is common.

## Genus—PODOSTEMON.

Annual or perennial submerged herbs of various habits in hill streams. Pedicels scattered and adnate to the stem or in terminal or lateral very short branches which are naked or scaly at the base. Flowers bisexual, sessile, enclosed in a little spathe, with 2 linear staminodes at the side of the staminal column. Stamens 2, filaments connate below. Ovary globose, 2 celled, style short, linear, subulate. Capsule long pedicelled, ovoid or ellipsoid; valves 3-5 ribbed, persistent or 1 deciduous.

### PODOSTEMON WALLICHII Br. (Pl. XI, Fig. 3.)

Perennial aquatic herb, about one inch or more in height, consisting of a flat, veined, lobulate frond. Veins radiating. Buds usually from between the lobes, rarely superficial, one flowered. Leaves, irregularly disposed, more or less connate, consisting of 5-7 scale-like sub-distichous fleshy deciduous parts. Pedicel ½ to ⅔ inch. Spathe tubular dilated at the mouth, invaginate at the middle. Stamen with subterete filament; anthers broadly ovate; staminodes 2, or with a third arising from the fork of the filament. Ovary ovoid, stigma thick, subulate, unequally divaricate. Capsule 8 ribbed, narrowed into the pedicel. Valves persistent incurved.

*Hab.* Common in the falls and hill streams of Khasia Mountains and other hills in Assam.

## Family—CERATOPHYLLEÆ

Slender submerged aquatic herbs Leaves dichotomously cleft into filiform toothed lobes Flowers monœcious Perianth segments in male flowers 6 12 each bifid Perianth segments in female flowers same as the male or sometimes 9 10 Ovary one celled ovoid Style subulate stigmatic on one side Fruit an ovoid coriaceous ellipsoid somewhat compressed nut

### Genus—CERATOPHYLLUM

Perennial submerged fragile branched herbs Leaves whorled dichotomously divided into filiform minutely toothed lobes stipules absent Flowers very small monœcious axillary sessile Male perianth or involucre of 6 12 narrow subvalvate bifid segments Stamens 10 30 sessile or filaments very short anthers erect extrorse connective truncate or 2 toothed at the apex dehiscence longitudinal Female perianth same as in male Ovary sessile 1 celled ovule solitary pendulous style subulate stigmatic on one side Fruit a small coriaceous ovoid or ellipsoid somewhat compressed nutlet terminating in a long subulate style Seed pendulous testa membranous

#### CERATOPHYLLUM DEMERSUM Linn (Pl II Fig 3)

Perennial submerged rootless much branched water plant densely leafy green to pale brown Leaves about 1 inch long in whorls profusely dichotomously branched Segments spreading in water but collapsing in a tassel when taken out Perianth subulate Male flower stamens sessile anther large white in female flower perianth as in male Ovary sessile 1 celled style subulate twice as long as the germ Fruit variable three horned

*Hab* Extremely common in freshwater tanks jheels lakes and other stagnant waters throughout India and Burma Flowering from January to March fruiting later

This submerged water plant is found in almost all the stagnant pools jheels tanks lakes etc During the germination of seeds the plant is slightly attached to the mud But later on as it grows up it gets detached due to the bubbles of Oxygen being caught up in the interstices of the capiliform leaves and exerting an upward pull as also does the mucilage excretion The plant then floats in the middle zone This species occasionally forms association with another species *Hydrilla verticillata* another common submerged plant These two plants may be called the chief constituents of the mass of free floating yet submerged vegetation called sometimes the pleuston

The abundance of growth of these plants sometimes entirely chokes the column of water in jheels lakes tanks etc These two plants by their peculiar vegetative structures are a suitable substratum for a large number of epiphytic algæ chiefly conjugatæ and Diatoms and not infrequently blue green algæ These microfloras supply food to mosquito larvæ Thus the larvæ find a suitable breeding ground in the presence of these plants The mosquito larvæ not only have in them a safe place for shelter but also a rich foraging ground in the presence of the unicellular algæ the larva s favourite food

Ceratophyllum mainly reproduces vegetatively and even a small piece of the plant is capable of developing quickly in a fresh mass. During winter the plant develops a peculiar type of winter bud known as (*Squamulæ intravaginales*) which is capable of growing into an individual plant. Seeds are also abundant. The eradication of these plants is therefore, not easy. But eradication is essential to maintain the healthy condition of water in a tank as also to prevent the breeding of mosquito larvæ. These two plants are also the chief agents against the self-purificatory action of water.

## *Monocotyledones.*

## Family—HYDROCHARIDEÆ.

Aquatic annual submerged herbs. Leaves radical, fascicled, alternate opposite, lamina undivided. Flowers regular, monœcious or diœcious, rarely bisexual, enclosed in an entire or 2 leaved spathe. Female flowers solitary; perianth superior, sepals 3 green or petaloid. Petals membranous or absent. In male flowers stamens 3-12, 1-4 seriate; anthers 2-celled. Ovary inferior, one celled. Placentas 3-6, or intruded; style or style arms 3-12. Fruit globose or ovoid, dry or pulpy rarely dehiscent. Seeds few or many.

### *Key to the genus.*

| | |
|---|---|
| I. Freshwater herbs : | |
| A. Stems branching, leafy; leaves small, spathes small, sessile. | |
| (*a*) Leaves whorled, perianth double, styles undivided . . . . . . . . | *Hydrilla.* |
| (*b*) Leaves scattered, perianth single, styles cleft | *Lagarosiphon.* |
| B. Stems absent or with stolons only or a creeping root-stock :— | |
| (*c*) Leaves all long and narrow, sessile, male scapes several flowered :— | |
| (i) Flowers unisexual, perianth single . . . | *Vallisneria.* |
| (ii) Flowers uni-or bisexual, perianth double . | *Blyxa.* |
| (*d*) Leaves mostly or all petiolate. | |
| (i) Ovary beakless, fruit wingless, flowers unisexual, scapes several flowered, 2-3 fid . . . . . . . . | *Hydrocharis.* |
| (ii) Flowers solitary, ovary beaked, fruit winged . | *Ottelia.* |
| II. Salt water herbs. | |
| Spathes 2 leaved, ovary beaked in all male spathes one flowered, perianth single . . . . . . | *Halophila.* |

## Genus—HYDRILLA.

Submerged leafly freshwater diœcious herbs. Leaves, short, sessile, verticelled, 3-4 nately whorled, or the lower opposite, oblong lanceolate 1/8 to nearly 1 inch long. Flowers very small, 1-4 in a verticel, diœcious. Male flowers much smaller than female. Male flowers shortly pedicelled, solitary in a subglobose muricate spathe; females sessile

1 2 in a tubular 2 toothed spathe Sepals 3 ovate or obovate green petals 3 oblong or cuneiform Stamens 3 anthers large reniform opening with an elastic jerk Pistillode minute Female flowers, sepals 3, linear green Petals 3 narrow Ovary produced beyond the spathe into a filiform beak 1 celled style 2 3 linear undivided stigmas fimbriate Fruit subulate smooth and muricate Seeds 2-3 oblong minute

### HYDRILLA VERTICILLATA Casp (Pl XXIII Fig 2)

Submerged aquatic freshwater herbs gregarious in habit, stem much branched slender flaccid with long or short internodes frequently rooting from the node branches with a short sheathing leaf at the base Leaves ⅛ to about 1 inch long sessile 4-8 in a whorl, linear or linear oblong apiculate entire or serrulate Flowers ⅙ to ¼ inch long perianth segments very variable Fruits smooth or muricate Seeds from 3 5 oblong pointed at each end lodged more or less as in Leguminous plants

*Hab* Common in freshwater lakes mostly floating in masses Flowering during the cold season

This is one of the most common submerged aquatics found in almost all freshwater tanks jheels lakes ponds and puddles It grows both from seed and from the detached stolons and also from the winterbuds The male flowers get detached and rise to the surface They float and may ultimately thus reach the female organs It is one of the most dominant species of the Hydrocharid formation It spreads rapidly and frequently chokes up an expanse of water thus becoming a pest of fresh water reservoirs The plant harbours a large number of epiphytic algæ which are a favourite food for the mosquito larvæ This plant therefore is a great hindrance to the anti malariological work and pisciculture It is detrimental to the self purificatory action of water by checking the development of the microplankton It further aids the development of an objectionable growth of larger aquatics on the surface

### Genus—LAGAROSIPHON

Submerged freshwater herbs Leaves scattered fasciculate or subverticillate the lower sometimes opposite serrulate Flowers diœcious males minute many in an ovoid bifid axillary sessile spathe females sessile solitary in a narrow oblong spathe Sepals 3 coloured petals 3 rather shorter than or as long as the sepals Male flowers stamens 2 or 3 opposite the sepals filaments short anthers ovate often with 2-3 staminodes Pistillode absent Female flowers Staminodes absent ovary oblong prolonged into a filiform beak styles 3 stout notched Fruit ovoid oblong or linear Seeds numerous covered with a thin mucous coat

### LAGAROSIPHON ROXBURGHII Benth (Pl III Fig 3)

A submerged leafy diœcious aquatic herb Root fibrous at first in the ground Stem long rather filiform of various lengths ascending through the water and finally floating on the surface with its alternate ramifications Leaves sessile in the older stems remote towards the apices

whorled, alternate or opposite, slightly stem clasping, oblong lanceolate, sword shaped, minutely serrulate, acute, 2-4 inches long and ¼ inch broad. In male flowers spathe ovoid, axillary, enclosing many flowers, paired, composed of 2 valves parting when florets are ready to be disengaged. Stamens 2, anthers dehiscing transversely. Female flowers axillary, sessile paired. Perianth 3 leaved, spreading, orbicular, concave and elevated on a slender pedicel. Ovary lanceolate, produced into a filiform flexuous beak, 2-3 inches long. Stigma lobed. Fruit a capsule as in the genus.

*Hab.* Common throughout the provinces; in freshwater tanks, jheels and flooded rice fields. Its luxuriant growth is observed during and particularly towards the latter part of the rains.

This submerged aquatic is of the same habit as *Hydrilla verticillata* and the life history of the two plants is nearly identical. The pollination here also takes place on the surface of the water and these plants are, therefore, called hydrophilous. The male florets burst from their covering, rise to the surface and float on their reflected petals. They may finally get entangled in the large corolla like stigmas of the female flowers. Like *Hydrilla verticillata* it forms floating masses of vegetation and has the same deleterious action on water.

The plant flowers a little earlier than *H. verticillata.*

Both these plants as also *Vallisneria spiralis* in earlier days in villages such as Serampore, Berhampore were commonly used, when moist, by sugar refiners to cover the surface of molasses; and Roxburgh notes that within " two or three days the operation is finished exceedingly well ".

Removing the weeds by mechanical means and excavation of older tanks, and subsequent sterilisation by means of lime and chlorine have been found to a certain extent effective in the eradication of these aquatic scourges.

## Genus—VALLISNERIA.

Tufted, stoloniferous, aquatic herbs rooted in the mud. Leaves very long, linear. Flowers diœcious. Male flowers many, minute, in an ovoid, 3 lobed, shortly pedunculate spathe. Female flowers solitary, in a tubular 3 toothed spathe, terminal on a very long filiform spiral scape. Sepals 3. Petals absent. Stamens 1-3 in male flowers, filaments rather thick, anthers didymous. Staminodes 3, each bifid in female flowers. Ovary narrow not produced upwards; stigmas 3, broad notched. Frut linear included in the spathe. Seeds many oblong, testa membranous.

### VALLISNERIA SPIRALIS Linn. (Pl. XXVIII, Fig. 2.)

Rooted water plants. Leaves radical developing from the root-stock with those of stolons, long, linear ensiform, narrowly ribbon shaped, length of the leaves varying with the depth of the water sometimes reaching up to 3 feet or more, about ¼ to ½ inch wide, translucent, entire or serrulate towards the tips; the cells are characterised by the rotation movement of the protoplasm. Male flowers many minute enclosed in shortly peduncled spathe, about ¼ inch long, bursting at the base when florets

are mature, then these flowers emerge and float on the surface of the water Pedicels slender stamens 1 3 Female flowers solitary enclosed in a 3 toothed spathe carried to the surface of the water by the gradual uncoiling of the filiform spiral scape, which after fertilisation again coils close and thus brings the ovary down to mature under water Fruit linear included in the spathe, many seeded, covering of the seed membranous, narrowed to the base

*Hab* Very common throughout the provinces profusely spreading on the bottom of tanks jheels and other freshwater reservoirs

This species although gregarious and tending by means of its stolons to spread over the bottom of tanks etc does not choke tanks so much as the former species mentioned In medium abundance this plant tends to keep tanks etc in a healthy condition by diffusion of Oxygen It thus helps to sustain the microplankton flora and therefore a tank self purificatory action It may, however when in great abundance tend to impede a flow and in this condition reverses its normal beneficial action on the water besides promoting a better breeding ground for mosquito larvæ

## Genus—BLYXA

Submerged tufted scapigerous annual herbs Leaves linear, acute, entire or minutely serrulate Flowers hermaphrodite or diœcious Scapes long or short male pedicellate several in a tubular 3 toothed spathe hermaphrodite or female flowers solitary sessile within a tubular 2 toothed spathe Sepals 3 linear Petals 3 linear longer than sepals Male flowers stamens normally 3 seriate one or more often reduced to a staminode anthers narrow erect Pistillodes 3 slender Female flowers staminodes absent or minute Ovary slender linear 1 celled beaked with parietal placentas styles very short stigmas 3 filiform Hermaphrodite flowers stamens 1 3 seriate 3 9 Carpels 3 united in a normal ovary Fruit linear included in a ribbed narrow ventricose spathe Pericarp membranous Seeds numerous oblong within a thin mucous covering smooth or tuberculate often tailed

### *Key to the species*

A Leaves not serrulate (broad at the base narrowed upwards)
- (a) Flowers diœcious stamens of male flowers 8 seeds distinctly tubercled shortly tailed — *B Roxburghii*
- (b) Flowers hermaphrodite —
  - (*) Stamens 9 seeds faintly tubercled without tails — *B Griffithii*
  - ( ) Stamens 3 seeds spinescent with long tails — *B echinosperma*

B Leaves serrulate —
- (a) Flowers hermaphrodite stamens 3 seeds sparsely *tubercled tails short or absent* — *B oryzetorum*

## BLYXA ROXBURGHII Rich

Aquatic plants rooted in mud Leaves 8 26 × ¼ to ½ inch radical linear broad at the base finely acuminate at the apex smooth Flowers diœcious numerous in succession white Male flowers scape axillary

straight, as long as or longer than the leaves, spathe one leaved, subcylindric. Perianth 3 leaved, segments lanceolate. Petals 3, linear, recurved, longer than the calyx lobes. Stamens 8, filaments of unequal length, shorter than the petals. Female flowers: scape shorter and thicker than in the male. Flowers as in the male, corolla lobes filiform. Style 3 cleft nearly to the base. Fruit 2-4 inches × ¼ inch. Seeds cylindric, more or less 3 sided, small, ½ inch in diameter, distinctly tubercled, shortly tailed.

*Hab.* Submerged, tufted, rooted aquatic annual occurring in stagnant rather shallow fresh water in most provinces. The process of pollination and fertilisation is similar to that of *Vallisneria.*

### BLYXA GRIFFITHII Rich.

Rooted water plant. Leaves 4 inches to 2 feet long, scape compressed. Flowers bisexual. Stamens 9. Fruit a capsule 2-2½ inches long, linear, narrow. Seeds about 1/20 inch faintly tubercled, without any tail.

*Hab.* Tufted aquatic common in Bengal, extending towards Malay Peninsula.

### BLYXA ECHINOSPERMA Hk.f.

Rooted aquatic herb. Leaves variable in length 6 inches to 4 feet × ⅛-½ inch narrowly linear, entire, or very minutely denticulate margins. Scapes filiform, length varying with the water level. Flowers hermaphrodite, 1 in each spathe. Calyx lobes 3, narrowly linear, obtuse, greenish. Corolla lobes white, often spirally twisted at the tips. Stamens 3. Stigmas 3. Capsule cylindric, 2-3 inches × ⅛ inch. Seeds spinescent, sometimes ½ inch long, with the long filiform tails at each end.

*Hab.* Tufted annual water-plants found generally in fairly deep water in tanks of Bengal and the Western Peninsula.

### BLYXA ORYZETORUM Hk.f.

A water plant of the same habit as the species above described. Leaves about 4-6 inches long. Scape short. Flowers bisexual. Stamens 3. Capsule 1-1½ inch by ⅙ inch. Seeds slightly larger than those of *B. Griffithii*, sparsely tubercled, tails very short or almost absent.

*Hab.* Abundant in the Khasia Hills, Assam. Jacquemont reports its occurrence in Kashmir also.

### Genus—OTTELIA.

Mostly submerged herbs. Leaves radical, crowded, long petioled, ovute-lanceolate, oblong or cordate. Flowers solitary, hermaphrodite, sessile, within a tubular long-peduncled spathe. Sepals 3, linear or oblong. Petals 3 longer than the sepals obovate or orbicular with fleshy basal appendages. Stamens 6-15, in 2-5 series; anthers erect. Ovary oblong beaked almost 6 celled: styles 6, linear bifid. Fruit oblong enclosed in the spathe 3-6 winged. Seeds many oblong, testa pulpy.

OTTELIA ALISMOIDES Pers.

Succulent flaccid aquatic herb. Leaves radical submerged variable in dimensions, long petioled from oblong cordate to broad cordate somewhat ovate-orbicular, smooth, membranous in texture, waved, 7-11 nerved; petioles radical three sided, length variable depending on the depth of the water. Flowers solitary. Spathe 1-1½ inch long, peduncles radical, varying in length with the depth of the water, wings of spathe undulate, unequal, mouth 5-6 toothed. Calyx 3 lobed, lobes small, green, lanceolate 3 nerved. Corolla 3 petalled, petals nearly orbicular, 1 inch in diameter, white, with a yellow base, reticulately veined, often with 3 small obcordate scales (nectaries) within the insertion of the petals. Anthers linear, erect. Ovary narrowly oblong. Styles 6-12, half 2-cleft. Placentas parietal 6-12. Fruit a capsule, oblong or ellipsoid, crowned with the withered perianth, six-grooved, 1 celled, six-valved. Seeds numerous attached to six sharp keels or placentas.

*Hab.* A common, submerged, annual, rooted, aquatic herb of shallow stagnant fresh waters occurring throughout India. This species grows along with and sometimes at about the same depth as *Vallisneria.* It is less abundant than *Vallisneria*, but may be locally abundant. It, however, tolerates water shallower than *Vallisneria* and in consequence is not infrequently found in flooded ricefields.

Genus—HYDROCHARIS Linn.

Floating water-plants. Leaves, orbicular or reniform, entire. Flowers monœcious. Male flowers in a peduncled 2-leaved spathe; female flowers solitary in the spathe. Sepals 3 herbaceous. Petals 3, membranous, white. Stamens 6-9, with 3-6 staminodes; filaments forked. Female flowers long peduncled, perianth leaves same as the male. Staminodes 6 in pairs. Ovary ovoid, 6 celled; stigmas 6, linear bifid. Fruit ovoid or oblong fleshy berry. Seeds many, testa pulpy full of spiral vessels.

HYDROCHARIS CELLULOSA Buch. Ham.

Aquatic stoloniferous floating herb. Roots fibrous rather bulbiferous. Leaves 1-1½ inch in diameter. Sepals small oblong. Petals broadly obovate, rumpled. Female flower with a fleshy tubercle at the base.

*Hab.* Floating in tanks and jheels of Bengal—more common towards N. Bengal.

Genus—HALOPHILA Thouars.

Submerged, mostly rooted, marine or brackish water herbs. Leaves in pairs from the axil of a scarious or hyaline scale at every node of a slender, creeping stem, ovate or oblong. Spathes of both sexes small, of 2 bracts, solitary, sessile, between the pairs of leaves. 1 flowered. Flowers monœcious. Male flowers stalked. Sepals 3. Petals absent. *Stamens 3 alternating* with the sepals, subsessile, linear-oblong. *Female* flowers sessile. Sepals 3, minute. Ovary long-beaked, 1-celled; styles 3, filiform, papillose all over. Fruit included, subglobose, beaked. Seeds many, ovoid; testa membranous.

### HALOPHILA OVATA Gaud.

A trailing water-plant rooting at the nodes, with 2 convolute scales at each node. Leaves 2-2½ inches, somewhat membranous, with a rather broad midrib.

*Hab.* In salt and brackish water, abundant, creeping along the sandy and muddy silt near the margin of the Chilka Lake, Ennur Salt Lakes, Calcutta Salt Lakes and other brackish water areas. Sometimes found to be acclimatised even in more or less fresh water pools and swamps.

## Family—SCITAMINEÆ.

Herbs, often large with a pseudo-stem of convolute leaf-sheaths. Leaves radical or cauline more or less membranous; sheaths generally large, clasping the stem; lamina with strong central vein and pinnate close secondary veins; petiole short or absent. Flowers hermaphrodite, rarely unisexual, irregular, solitary spicate. Bracts membranous or herbaceous; bracteoles membranous or absent. Perianth 2 seriate, superior; outer segments 3, calycine, rarely petaloid, free and imbricate or connate in an entire toothed or spathaceous tube; inner segments petaloid connate in a long or short corolla tube; free or adnate to the petaloid staminodes; limb 3 partite, the segments free or connate. Stamens only 1 perfect, the remainder replaced by petaloid staminodes, anthers linear, 2-celled, rarely of 1 cell on the margin of a petaloid connective. Ovary 3 celled, inferior; style usually slender with 2 short stylodes crowning the ovary; stigma usually entire or sub-entire. Fruit a loculicidally 3 valved capsule or indehiscent and membranous or fleshy, usually crowned by the remains of the perianth. Seeds often arillate.

### Genus—ALPINIA.

Tall herbs with leafy stems and horizontal root-stocks. Leaves oblong or lanceolate. Flowers in terminal racemes or panicles, bracteoles large, sometimes covering the buds. Calyx loosely tubular, 3 toothed. Corolla tube cylindric rarely longer than the calyx. Corolla lobes oblong or linear-oblong, upper usually broader, more convex than the lateral. Stamen 1 perfect; filament flattened; anther cells diverging at the top occasionally with an orbicular crest; lateral staminodes minute or obsolete. Lip spreading often orbicular with incurved margins, sometimes with 2 subulate processes at the base of the claw, ovary 3-celled; style filiform; stigma globose. Fruit globose usually dry or fleshy berry. Seeds globose or angled.

### ALPINIA ALLUGHAS Roscoe. (Pl. XIII, Fig. 2.)

A stout, perennial herb with aromatic tuberous roots. Leaves 8-18 × 1½-4 inches, sessile or nearly so, linear-oblong or oblong lanceolate, acuminate, cuspidate, glabrous; sheaths long, smooth, striate, compressed; ligule nearly ¼ inch long, obtuse, glabrous. Flowers inodorous, pink, in erect, decompound, lax or densely flowered panicles, 6-12 inches long; pedicels short; bracts small ovate cupular. Calyx subcampanulate, pubescent, the mouth oblique, obtusely 2-3 toothed.

Corolla tube as long as the calyx lobes longer than the tube, linear-oblong, cymbiform, dorsally pubescent, shortly spurred below the hooded tip Lip nearly more than 1 inch long including the claw, pink, obovate-cuneate or suborbicular 2 fid the margins waved and erose claw as long as the limb with 2 linear subulate glands obscurely crested Stamens shorter than the lip, connective not or obscurely crested Style glabrous stigma small Fruit black, thin, globose ⅔ inch in diameter, irregularly rupturing Seeds many, small black, angular

*Hab* Throughout Bengal common in Sundribuns and other riparian areas

This species although not an aquatic plant proper is frequently met with on wet ground along with taller grasses such as Phragmites Karka, Cyperus species and others especially near and along the riparian and estuarine regions They are gregarious in habit sometimes forming pure associations and covering fairly large areas where due to the shade and moisture adult mosquitoes harbour

## Family—PONTEDERIACEÆ

Fresh water or marsh herbs rooting in mud and erect or floating Leaves erect or floating parallel nerved unifoliate springing from the buried root stock or from the joints of the floating stoloniferous stems which often develop as offsets basal leaf long petioled, blade floating or up raised Flowers slightly irregular, hermaphrodite, arranged in subumbellate racemes or spikes rarely fasciculate or paniculate at the ends of leaved stems or branches Bract sheathing spathe like under the inflorescence, minute or obsolete under the flowers Perianth inferior petaloid marcescent usually tubular, unequally 6 partite Stamens 6 or 3, unequally adnate to the perianth tube or to the base of the perianth lobes usually declinate the upper shorter filaments free anthers oblong or rarely ovate with 2 parallel distinct cells Ovary superior 3 celled with axile placentas or 1 celled with parietal placentas style filiform or columnar stigma terminal entire or lobed Fruit a dry membranous loculicidally 3 valved capsule Seeds ovoid or oblong testa longitudinally ribbed

### *Key to the genera*

| | |
|---|---|
| Petioles not enlarged or inflated thus keeping the plant afloat in water perianth segments free one longer than the rest its filament horned on one side | *Monochoria* |
| Petioles often enlarged or inflated towards the base and thus keeping the plant afloat perianth distinctly tubular below anthers equal filaments not horned | *Eichornia* |

## Genus—MONOCHORIA

Fresh water or marsh herbs Root stock creeping clothed with leaf-sheaths Leaves radical and solitary at the top of the emerging stem or branches ovate cord[illegible] leaves long those of cauline [illegible] sessile within the axil of [illegible]led or peduncled and subspicately short pedicelled, spathe complicate below the

raceme. Perianth campanulate; tube absent; lobes partite, distinct, subequal, stamens 6; one larger than the other with its filament horned on one side; anthers basifixed, dehiscing by a terminal, ultimately elongate slit. Ovary 3-celled; style filiform; stigma minutely 3 lobed. Fruit oblong, a membranous loculicidal capsule. Seeds small, ovoid or ellipsoid, obtuse, many ribbed.

*Key to the species.*

A. Rootstock elongate, creeping; leaves hastate, sagittate or cordate; flowers long pedicelled, subumbellate or racemose . . . . . . . . . . . . *M. hastaefolia.*

B. Rootstock short, suberect, leaves ovate or subreniform, ovate-cordate or linear ovate; flowers short pedicelled subspicate :—

(i) leaves ovate cordate, flowers numerous . . . . *M. vaginalis.*

(ii) leaves linear or narrowly ovate; flowers few . . *M. vaginalis var. plantaginea.*

MONOCHORIA HASTAEFOLIA Presl. (Pl. XVI, Fig. 2.)

Perennial fresh water or sometimes brackish water marsh or aquatic herbs. Rootstock stout, creeping and rooting below, spongy, clothed with the remains of old sheaths. Leaves 4-8 by 2-6 inches sagittate, hastate or cordate, obtuse, acute or acuminate, smooth and glossy, the basal sinus more or less deep; petioles of the floral leaves tumid above and embracing the short scape; petioles of the radical leaves 1½ to 2 feet long, with a broad sheathing base. Inflorescence subumbellate or racemose, *flowers crowded long-pedicelled, ⅔ to 1 inch across, of a brilliant* purplish blue or of violet-blue dotted with red; perianth segments 5-8 inches long, twisting corkscrew fashion round the fruit when withering, large segments obovate, ¼ inch wide; the smaller segments oblong, ⅙ inch wide, all with 3 strong parallel large anther ⅙ inch long, spurred, with an acute horn at one side; anther linear oblong, the large anther blue, the small anthers yellow. Ovary ellipsoid or ovoid; style long; stigma obscurely 3 lobed. Capsule ⅜ inch long, ¼ inch in diameter ellipsoid, subglobose or oblong, pale, with many fine brown ribs.

*Hab.* Rather common in all the provinces throughout India and Ceylon, in ricefields, flooded areas or marshes or margins of tanks, canals, etc., sometimes in brackish water, at low elevations. Flowering during the rains or just after.

MONOCHORIA VAGINALIS Presl. (Pl. XVI, Fig. 3.)

An aquatic or marsh herb with perennial suberect or creeping spongy rootstock, leaves variable, 2-4 inches by 1-2 inches ovate-cordate or cordate, acute or acuminate, 5-7 nerved; petioles of the lower leaves suberect, long, terete, tapering, fistulous, smooth, 6-12 inches long; those bearing inflorescence are swollen in the middle, the peduncles emerging from the channelled sheaths of these uppermost leaves; those that do not bear flowers are enlarged into a sheath which embraces the exterior leaves. Raceme subspicate, short peduncled, at first globose, the rachis lengthening as the flowers expand, after flowering time drooping few or many flowered; pedicels about ¼ inch long shorter than the perianth. Flowers

pretty, blue dotted with red Perianth campanulate, 6 partite, the 3 exterior segments smaller oblong, the three interior obovate Filament of the large anther with an acute horn on one side, filament of the smaller anthers filiform, anthers linear oblong, the larger anther blue the rest yellow Ovary ellipsoid, glandular, style long, stigma 3 lobed Fruit ellipsoid, less than ½ inch long, glandular outside Seeds ellipsoid, rounded at both ends, pale with many brown ribs

*Hab* Common throughout India occurring in ricefields and marshes and sides of tanks, canals and khals Flowering during the rains

### VAR Plantaginea

An annual diffuse, rather trailing herb of marshes Leaves petioled, narrow, rather linear-cordate, obtuse, lobes semicircular, petioles 3 4 inches long, round, variously curved Raceme few flowered Flowers rather large for the plant Perianth segments lanceolate, the interior three narrower Capsule oblong, three celled, 3 valved Seeds round

*Hab* Common in all the provinces in marshy and swampy areas rather small low delicate herb—flowering during the rains

### Genus—EICHORNIA

Perennial floating rooted herbaceous waterplants Stem a complex sympodium Leaves axillary appearing to develop in rosettes with long or short inflated petioles, leaf lamina obovate to sometimes broadly rounded Inflorescence a spike enclosed in a spathe Flowers trimorphic, heterostyled, somewhat funnel shaped, pale violet in colour Perianth 6 in two series, lower whorl of 3 smaller than the upper Stamens 6, 3 long and 3 short Ovary trilocular with a 3 lobed stigma Fruit an egg shaped or slightly elongated capsule with withering remains of perianth attached to it Seeds many ovoid or oblong ovoid with longitudinal ridges

### EICHORNIA SPECIOSA Kunth

A gregarious floating or rooted (when stranded on wet soil) waterplant with rosettes of leaves, usually 1-2 feet tall from the surface of water Roots fibrous a bunch of dense bushy mass often floating in deeper water, sometimes penetrating the soil on reaching the bottom in shallow, lowland waters These roots are pinkish violet due to the presence of the colouring pigment Anthocyanin The masses of fibrous roots often conceal the so called root stock or the submerged rhizome This is the stem proper and is the main seat of vegetative propagation Experiments proved that this root stock or rhizome even when cut to pieces and left in water are capable of developing into new plant Stem is of a complex sympodium type producing stolons which are generally transformed into a ramifying 6 8 inches long and ½ inch thick terete offsets These branch out from the parent plant with rosette of small young leaves at their end Roots develop at the node of each of these rosette of leaves and thus the young plant becomes self supporting When the offsets or runners as they are sometimes called are broken or wither away the young plants continue their rapid propagation Those attached to the parent plant soon form a colony around the mother plant by means of the

offsets coming out in all directions. Thus expanding centrifugally develop within a short time a matted mass of floating vegetation (Photo V). From such a congested mass of growth it becomes difficult to separate individual plant. The death of the mother plant in such a crowded growth is due only to its being overgrown and submerged by its progeny. Leaves with a long or short petiole which varies in length according to the nature of their growth in different types of water areas. In Bengal under favourable conditions and suitable localities the leaves sometimes reach a height of more than three feet. The petiole is inflated near the middle portion as bladder like structures consisting internally of large air chambers which aid the plant to float with their sail like ovate, obovate, broadly rounded or rarely circular leaf-blades. Thus provided with bladders the plants float and travel far and wide into new areas carried by wind or by current of water. The diameter of the bladder-like expansions in the petiole and leaf lamina is widely variable. In congested growth the leaf stock is much more elongated and the leaf-blade is acutely obovate; where as in plants stranded in mud and wet soil, the petioles and leaf-blades are much shortened and give quite a distinct appearance. Due to such variation in leaves the dwarfed forms are sometimes mistaken as separate species. In these rooted plants of moist soil the leaves are very small sometimes dwindling into 2 inches long petioles and 1-2 inches round leaf-blades. In these plants the bladders of the petioles are very prominent and portions of these bladder are sometimes coloured pale pink or pinkish violet like that of the submerged roots. Such dwarfed specimens are met with in half dried ricefield swamps, marshes, and sides of dried up ponds, etc. Inflorescences 6 inches to 1 foot or more long erect spikes enclosed in irregularly sheaths which are often smeared with mucilage. They usually develop from the axil of a deformed leaf with somewhat clasping base and bend down in the water after flowering. The spike bears 8-12 beautiful lilac or pale violet funnel-shaped trimorphic heterostyled flowers. Flowers slightly irregular. Perianth 6 lobed, the upper 3 larger than the lower 3 and has on each of them a large blotch of blue with an oblong or pear shaped spot of bright yellow in the centre. Stamens 6, inserted in the perianth lobes, all curved toward tips, the three longer and 3 shorter; filaments of the longer stamens vary from 3/4 to 1 inch and those of the shorter about 2/5 to 1/2 inch; the anthers of both sets are about 1/10 inch long and 1/20 inch broad. Ovary superior, 3-celled with 3 connate branched style; stigma mesostylous, *i.e.*, at a level with the anthers of the 3 upper stamens, 3 lobed, lobes minutely hairy. Placenta axile. The fruit is a trilocular loculicidal egg-shaped or elongated, cone-like capsule, enclosed in the persistent perianth when ripe. They immerse as the mature fruits are heavier than the water. Consequently the seeds are discharged under the water sinking in the bottom. Seeds minute, oval, broader at the base, attenuated at the point of attachment to the placenta 16-12 m.m. × 12-16 m.m. Testa hard with 12-15 longitudinal prominent ridges. The seeds can remain dormant for several years (5-7 as recorded recently by Prof. P. Parija of Cuttuck).

*Hab.* This plant commonly known as water hyacinth is a native of Brazil. It has acclimatized and established in Bengal, Assam and Burma for some time from as early a period as 1896 or thereabout. Flowering throughout the year, fruiting in September and October.

The seedlings germinate in the rains from June to July and under suitable conditions may develop into a full fledged plant within the course of three or four months bearing flowers in September or October Abundant vegetative growth is mainly responsible for its rapid propagation although seeds are by no means less active agent in continuing its progeny Production of seeds in nature thus further complicates the question of eradication of this pest The life history of this plant under different ecological conditions as sketched in previous pages indicates its exceptional vital powers

Danger of economic paralysis due to the existence of this plant in huge masses in the water areas need not be emphasised, as we believe that such a stage in the history of the eradication of this pest is long over Various methods destroying the pest have been attempted without tangible results We have strong faith in the potential strength of organised manual labour in which co operation may be made with a wage hunter, the Rajas the Maharajahas as also the state Sporadic evidence of wonderful effect of control of this plant by united manual labour has been evidenced in Brahmanbaria and a few other places too For the salvation of the country we, therefore again advocate with all the emphasis we can command, of applying united effort in dragging out from every nook and corner in season and outseason even a bit of a single plant detected and bring them at a safe place especially the root-stock or rhizome finally burning them after they are dried The plant should be lifted up with their root stocks during April and May and must be burnt to ashes by the first week of May to the 1st week of June before the advent of the rains So called economic use of the plants are of little commercial importance This must not be an excuse to tackle the problem of eradication lightly

## Family—XYRIDEÆ

Erect, tufted, scapigerous glabrous marsh herbs Leaves radical, linear or subulate Scape as long as or shorter than the leaves, terete, angled or compressed naked Flowers hermaphrodite, sessile in the rigid, dark brown imbricating bracts of a terminal head or spike, opening one at a time Bracts orbicular or obovate, coriaceous convex, persistent. Perianth inferior, 2 seriate, Sepals (or bracteoles) 3, deciduous, mem branous, the lateral small narrowly boat-shaped, arched keeled or winged, the dorsal sepal petaloid, broader, arching over the young flower, sometimes absent Petals 3 clawed, obovate or spathulate, coloured Stamens 3 perfect, shorter than the corolla-lobes, anthers sagittate, staminodes 3 alternating with the corolla lobes or absent Ovary superior, 1 celled or imperfectly 3 celled with parietal placentas, style 3 fid with long arms, stigmas capitate or dilated Fruit a loculicidally 3 valved capsule or with the top circumscissile Seeds oblong, strongly ribbed

### Genus—XYRIS

Character those of the order

*Key to the species*

Leaves distinctly flat linear form obtuse 1 2 feet long ... *X indica*

Leaves not distinctly flat narrowly linear acute 3 8 inches long ... *X pauciflora*

### XYRIS INDICA Linn. (Pl. XVIII, Fig. 3.)

An erect annual 6-20 inches tall herb. Leaves radical, sword shaped up to 3/8 inch broad spongy smooth 1-2 feet long, usually shorter than but sometimes as long as the scape, narrowed to an obtuse or acute tip. Scape deeply grooved acutely angled, each supporting a round or ovoid, flower bearing head; bracts many orbicular or cuneatly obovate, usually broader than long, dark red brown, shining very coriaceous with scarious margins. Flowers bright yellow, 1/2 inch across. Lateral sepals narrowly boat-shaped dorsally winged, the wing serrulate. Claw of petals as long as the sepals; limb obovate or sub-orbicular, erose, veined. Stamens 3, filaments short, broad; anthers oblong; ovary unilocular or imperfectly 3 locular; style 3 armed stigmas truncate capsule ovoid. Seeds ellipsoid very strongly ribbed.

*Hab.* Common in marshes in North Bengal at the foot of hills extending along the Eastern Himalayas up to the Khasia Hills. Flowering in November and December. Fruiting in January and February.

### XYRIS PAUCIFLORA Willd.

A small tufted marshy herb. Leaves narrowly linear, rigid 3-8 inches long, rarely 1/8th inch broad, equalling or shorter than the scape, strongly nerved, scaberulous, on the surface or margin or smooth acute, scape subterete striate or compressed and 2 edged supporting globose rarely ovoid spike. Bracts orbicular obovate pale with often a green tip. Flowers with lateral sepals oblanceolate, acuminate, keeled, hyaline, quite glabrous.

*Hab.* Common in marshes spreading from Nepal eastwards to Bengal and Burma.

## Family—COMMELINACEÆ.

Perennial, slender, prostrate herbs. Leaves with a basal membranous closed sheath with parallel nerves. Inflorescence various, mostly terminal cymes or panicles. Flowers actinomorphic or somewhat irregular, hermaphrodite or rarely polygamous, in axillary clusters, blue or white. Perianth inferior, 6 lobed, 2 seriate, outer series of 3 segments, herbaceous sepal like, often persistent; inner series of 3 petaloid segments, petal like, free or united below in a tube, spreading above, marcescent. Stamens 6, or fewer by abortion, inserted on the base of the segments; filaments often bearded with moniliform hairs, anthers basifixed, oblong or globose dehiscing by longitudinal slits or by apical pores. Ovary superior, 2-3 celled; style terminal, simple; stigma small, capitate or 3 fid. Fruit a loculicidal capsule rarely indehiscent. Seeds angled, testa smooth, ridged, rugose or reticulate.

### *Key to the genera.*

Cymes solitary, enclosed in spathaceous bracts . . . . *Commelina.*
Cymes paniculate naked . . . . . . . *Aneilema.*

## Genus—COMMELINA

Slender herbs creeping below Leaves ovate, lanceolate or linear with lax sheaths petioled or sessile Flowers in usually bifid cymes emerging at one time from a terminal, complicate, or funnel shaped or hooded spathe Flowers of the upper cyme branch small deciduous, of the lower fertile Fruiting pedicel and capsule retracted within the spathe Sepals 3 membranous the inner 2 often connate below Petals 3, longer than the sepals one larger than the others and often clawed Stamens 3 perfect and 2 3 imperfect, anthers oblong, dissimilar, one usually larger than the others Ovary 3 rarely two celled Fruit a loculicidal capsule Seeds elliptic or angular by mutual pressure, testa reticulate, pitted or rugose

### COMMELINA SALICIFOLIA Roxb (Pl XXI, Fig 1)

A diffuse slender herb Stem with long internodes Leaves linear lanceolate, 3-6 inches x 1/6 1/2 inch nearly glabrous sheaths ciliolate Spathes 1½-2 inches long, peduncled, lanceolate complicate, axillary, solitary, acute or acuminate, base rounded, branches of cyme 1-2 flowered Flowers small, dark blue Seeds globose, smooth, truncate, appendiculate, black, powdered with white

*Hab* Common in all the provinces from Assam and Bengal to South India

## Genus—ANEILEMA

Simple or branched often tuberous rooted herbs Leaves usually alternate, sometimes all radical occasionally clustered under the inflorescence Flowers in axillary or terminal panicles bracts not spathaceous bracteoles small Sepals 3 free membranous Petals 3 obovate equal Stamens 2-3, filaments naked or bearded anthers oblong one usually smaller or larger than the others, staminodes 2 4 rarely with minute anthers Ovary 2-3 celled Fruit a loculicidal capsule Seeds with a thick hard rugose or pitted testa

### ANEILEMA HAMILTONIANUM Wall (Pl XIII Fig 4)

Sparingly branched herb with rather stout stem creeping rooting at the nodes Leaves linear oblong flat glabrate sessile acute or subacute base cuneate Petals white or rosy Stamens with all naked filaments Fruit linear oblong acute seeds scabrid or flocculent biseriate

*Hab* A sparingly branched weed of marshes and wet places common in the Upper Gangetic Plain of N Bengal to Assam

## Family—JUNCACEÆ

Erect perennial or rarely annual herbs Stem tufted or a creeping rhizome mostly leafy only at the base Leaves flat terete linear or reduced to sheaths Flowers hermaphrodite regular in axillary or terminal usually small cymes bracts small scarious green or white membranous or brown coriaceous Perianth segments 6 persistent

in 2 whorls, glumaceous or coriaceous rarely scarious, greenish or reddish brown to black or rarely white or yellowish. Stamens 6, adnate to the base of the perianth lobes or hypogynous, occasionally the 3 of the inner series absent; filaments filiform; anthers basifixed. Ovary 1-3 celled or 1 celled superior ovary. Fruit 3 valved loculicidal capsule. Seeds erect sometimes tailed with the membranous testa produced at each end.

### Genus—Juncus.

Perennial or rarely annual glabrous herbs. Stems simple under the inflorescence. Leaves radical, a few near the base of the stem, linear or terete or reduced to sheaths. Flowers small usually clustered in fascicles or 2 fid cymes, either sessile capitate or unequally peduncled paniculate, the whole inflorescence terminal or subterminal on the scape like stems with 1-3 leafy bracts. Perianth with 6 glume like segments, free lanceolate or oblong, often with scarious margins, the 3 outer keeled or with thickened midrib. Stamens 6, rarely 3, hypogynous or nearly so; anthers oblong, or linear, erect, dehiscence longitudinal, introrse. Ovary 1-celled or imperfectly or perfectly 3-celled; style filiform; stigmatic arms 3, filiform often spirally twisted. Fruit a capsule, dehiscing by 3 valves leaving a central column. Seeds small ovoid; testa striate, reticulate or transversely lineate.

### Juncus prismatocarpus R. Br.

Plants variable with short cæspitose root-stock. Stem erect, terete or compressed sometimes decumbent, rooting at the nodes, leafy not septate. Leaves 2-10 inches by 1/16-1/8 inch always shorter than the stem, filiform, or broader, soft compressed or terete or 1 or many-tubular indistinctly externally distantly septate. Inflorescence cymose with erect or spreading branches, irregularly compound; lower bracts leafy erect shorter than the cyme heads densely 6-10 flowered; floral bract hyaline, lanceolate, long, acuminate. Flowers green or brown sessile. Sepals of glumaceous subulate or linear lahceolate. Stamens 3, much shorter than the sepals; anthers oblong. Capsule usually longer than the sepals prismatic or conical seeds very minute apiculate, obovoid or ellipsoid; testa oppressed, reticulate.

*Hab.* Common in very moist soil North West Bengal, the commonest rush met with everywhere in very wet places of the Sikkim Himalayas.

## Family—PALMEÆ.

Shrubs or trees, sometimes climbing, solitary or gregarious, naked or prickly. Stems stout, simple or slender, scandent or decumbent, rarely branched above, often covered with persistent bases of leaves. Leaves alternate in a terminal cluster or in climbing species more or less scattered, sometimes very large, entire, pinnatisect or palmate, or pinnately or digitately divided, the segments or leaflets folded induplicately or reduplicately in bud often expanded at the base into a fibrous sheath. Flowers small regular, hermaphrodite, monœcious or diœcious sometimes polygamous, arranged in an often paniculate inflorescence enclosed in a hard sheath (spadix) either amongst or below the leaves. Spathes various, sometimes numerous and enclosing the peduncle and branches of inflorescence, few leathery or membranous; 3-bracteolate, bracteoles connate

below Perianth 6 in 2 series in each series three (sepals and petals) usually all free, imbricate or valvate Stamens usually 6, in 2 series, rarely many anthers 2 celled versatile globose or linear, splitting longitudinally Ovary superior 1-3 celled rudimentary or absent in the male flowers, stigmas 3 usually sessile Fruit 1-3 celled drupe or hard berry Pericarp smooth rough often fibrous sometimes covered by reflexed scales, seeds free or adherent to the endocarp

## *Key to the genera*

Leaf segments linear dwarf palms with creeping underground branched stem or rootstock spadix with monoecious flowers fruit combined into a large dense woody head — *Nipa*

Leaf segments with induplicate sides tall or short soboliferous palms with stems covered with old leaf bases spadix with dioecious flowers fruit small berry with fleshy pericarp — *Phoenix*

## Genus—NIPA

Prostrate aestuarial gregarious palms with underground branched stem Leaves pinnatisect leaflets lanceolate plicate Spathes many sheathing Spadix terminal branched, erect drooping after fruiting Flowers monœcious male in a catkinlike lateral branches of the spadix female in a globose terminal head Perianth lobes 6 glumaceous Male flowers minute mixed with setaceous bracteoles Sepals 3 linear, imbricate with broad truncate inflexed tips Petals smaller Stamens 3, filaments connate in a column anthers basifixed linear Pistillode absent Female flowers much larger than males Perianth of 6 similar displaced segments Staminodes absent Carpels 3 with free apices each with an oblique stigmatic line Fruit large globose agglomerate mass of many obovoid hexagonal 1 celled and 1 seeded ripe carpels with pyramidal tips and infraapical stigmas Pericarp fibrous Seeds erect grooved on one side testa coriaceous

### NIPA FRUTICANS Wurmb (Pl XVIII Fig 4)

Root stock stout leaves 15-30 feet leaflets 4 5 feet rigid glaucous beneath petiole 4 5 feet very stout Spadix 4-7 feet, peduncle 3-4 feet Carpels 4 6 inches long smooth brown Fruit as large as a man s head when ripe deep brown

*Hab* Abundant in the lower parts of the delta of the Ganges and other salt swamps of South Burma Flowering in March to April Fruiting later in May to June

The plant forms a pure association of its own in mangrove swamps near the seaface and along the banks near the mouths of the rivers or on flooded brackish water areas within the tidal zone In the Sundribuns *Nipa* association either pure or mixed with *Phœnix paludosa* frequently forms the chief constituent of the mangrove formation Such an association of this graceful palm spreading over a deltaic region adds to the beauty of the landscape and the plants with their large leaves like those of Coconut palms rising nearly from the ground are easily distinguished from a distance In the estuarine areas where it is predominant it is a source of commercial importance The leaves are profusely used as

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### JUNCUS PRISMATOCARPUS R. Br.

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Leaf segments with induplicate sides tall or short soboliferous palms with stems covered with old leaf bases spadix with dioecious flowers fruit small berry with fleshy pericarp — *Phoenix*

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NIPA FRUTICANS Wurmb (Pl XVIII Fig 4)

Root-stock stout, leaves 15-30 feet, leaflets 4-5 feet, rigid, glaucous beneath petiole 4-5 feet very stout Spadix 4-7 feet, peduncle 3-4 feet Carpels 4 6 inches long smooth brown Fruit as large as a man s head when ripe deep brown

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exceptionally good thatching material. Local people prepare a kind of country liquor by tapping. Sometimes attempts are made to manufactu sugar from the juice obtained from tapping the younger inflorescences.

## Genus—PHŒNIX.

Tall or low simple or soboliferous palms. Leaves pinnatisect, leaf lets lanceolate or ensiform with induplicate margins. Spadices severa interfoliar, branched, erect or drooping in fruit. Flowers diœcious small yellowish coriaceous. Male flowers: sepals 3 united in a cuplik 3 toothed calyx. Petals 3 obliquely ovate, valvate. Stamens 6; fila ments short subulate; anthers erect dorsifixed. Pistillode minute o absent. Female flowers: globose with 3 accrescent calyx as that of the male. Petals 3 rounded, imbricate. Staminodes 6, free or connate in a 6 toothed cup. Carpels 3 free. Stigmas sessile, uncinate. Fruit oblong terete, 1 seeded with a terminal stigma, a fleshy pericarp and a membranous endocarp. Seeds oblong, ventrally grooved.

### PHŒNIX PALUDOSA Roxb.

Gregarious subarboreous palms. Trunks straight, 6-25 feet tall, 12-18 inches diameter often as thick as a man's leg, more or less inclined, soboliferous annulate. Leaves pinnate, oblong from 3-10 feet long with the base extended into a multitude of tough fibres, that embrace the stem and interior leaves. Leaflets solitary opposite and alternate bifarious ensiform, 1-2 feet long the lower few pairs short and spinous, the rest flaccid, smooth with acute filiform points, white or farinose beneath. Spadix with spreading branches. Male spadix with its peduncle 1½ feet compressed: spathe as long, scurfy, female spathe shorter. Male flowers ¼ inch long, calyx cupshaped, corolla united at the base into a firm receptacle which supports the stamens, filaments 6, short. Female flowers on a distinct plant, calyx and corolla as in the male, subglobose with 6 staminodes. Fruit a berry about ½ inch long mucronate, ovoid of the size of a field bean, when fully ripe of a deep shining black purple, the pulp is a dirty locking soft greenish black substance of an intolerable taste. Seeds cartillaginous.

*Hab.* Common along the estuarine regions from Bengal to Burma and the Andaman Islands. It is particularly confined to the Sundribuns where it forms a pure association of impenetrable woods covering extensive tract. The trunks of smaller trees are used as walking sticks and it is believed that snakes get out of the way of any person having such a staff. The longer trunks are used as rafters for thatching purposes.

## Family—TYPHACEÆ.

Aquatic or marsh herbs with perennial creeping rhizome clothed with distichous scales. Leaves mostly radical, elongated, linear, erect or floating, spongy, sheathing below. Flowers small or minute, monœcious, or by abortion diœcious, densely crowded in globose or cylindric, unisexual bracteate spikes of which the upper are males, the females below; the two sexes contiguous or remote from each other. Perianth of very slender hairs or membranous green scales mixed with imperfect

ovaries or stamens Male flowers Stamens 1-7, filaments free or variously connate anthers 4 celled linear, erect, basifixed, the consecutive thickened often produced Female flowers Ovary 1-2 celled stalked narrowed into the style Style free, short or long persistent laterally papillosely stigmatic Fruit small, dry membranous or drupaceous, at length splitting Seeds pendulous with a striate testa

### Genus—TYPHA

Aquatic or palustrine perennial herbs Leaves erect, spongy Flowers small in very dense superposed cylindric spikes, often intermixed with dilated tipped hairs Perianth of capillary hairs, or in the male flowers obsolete Stamens 1-or more anthers with tips of connective thickened Ovary borne on a slender, usually densely hairy gynophore or in the axis of membranous spathulate bracts 1 celled fusiform narrowed into a slender persistent style with a clavate or filiform stigma Fruit very minute fusiform detached with the hairy gynophore Pericarp membranous indehiscent or follicular, dehiscing by an apical lid Seeds often adnate to the wall, with striate testa

### *Key to the species*

| | |
|---|---|
| Leaves trigonous above the sheath pollen 4-globate | *T elephantina* |
| Leaves semi-cylindric above the sheath pollen simple | *T angustata* |

### TYPHA ELEPHANTINA Roxb (Pl XXI, Fig 2)

A tall gregarious perennial herb of standing water or flooded areas Stem a thick rhizome stoloniferous creeping underneath the *muddy soil*, *the* upper part projecting high out of the water sometimes reaching a height of 6-12 feet straight round smooth, glossy, jointed at the insertion of the leaves enclosed below *in a sheath, naked near the* ament, as thick as a lead pencil or nearly ½ inch in width the texture spongy Leaves 2 rounded long ensiform, *very smooth* all over, *deep* green, near the sheath below slightly convex on the outside concave within, from 4-6 feet long above the sheaths ¾ 1½ *inch* broad, sheaths smooth embracing the culm and the *sheaths of the inner younger leaves* Male spike 8 12 inches long, rachis clothed with *short* often forked hairs Bracts of the male flower 3 or more Anthers 1-5, linear, yellow with green tops caducous, leaving a *naked withered* receptacle, pollen 4 globate Female flower (brown) on much stouter spikes, situated below the male spike 6 10 inches by ⅓-1 *inch* in diameter Flowers mixed with clavate pistillodes bracteole somewhat leaflike with falcate tips much longer than the fine capillary perianth hairs, which are shorter than the lanceolate stigmas Seed oblong carried about with the wind by means of persistent downy filiform perianth

*Hab* Commonly found in stagnant fresh or brackish [illegible] slow running *rivers and streams* which do not dry up in the [illegible] sometimes on muddy and wet soils too Flowering during the [illegible] cold *season* It extends from North West India *to* [illegible]

The Leaves of the plants are used for thatching [illegible] screens are also made of the leaves They [illegible] elephants

### TYPHA ANGUSTATA Bory and Chaub.

A robust marsh plant, up to 10 feet high. Leaves 8 feet long ½ to an inch broad, semicylindric, above the sheath, acute. Male and female spikes separated by considerable interval, up to 12 inches long, brown. Male flowers paler and more slender. Pollens simple. Female flowers mixed with clavate sterile pistillodes. Bracteoles of female flowers subspathulate, equalling the linear stigmas, both longer than the hairs.

*Hab.* Common in all districts from the sealevel to a height of 2,500 feet. This plant is also of the same use as the above species. Cook mentions that a yellow cake called ' Bur ' is made of the flowers and these cakes are much eaten by all classes of inhabitants in Sind.

## Family—AROIDEÆ.

Perennial aquatic, marsh or terrestrial herbs, with rhizomatous or tuberous stems, sometimes climbing by aerial roots. Leaves alternate in shrubby species, in herbaceous species solitary, clustered or radical, often fleshy or coriaceous, simple, entire or lobed, often appearing without or after flowers, petioles with sheathing bases. Flowers hermaphrodite, monœcious or diœcious, sessile or shortly pedicelled which is more or less enclosed in a green or coloured spathe; if unisexual the males usually towards the apex and female at the base of the spadix with often neuters between them and above the males. Perianth absent or of scales. Stamens in hermaphrodite flowers 4-8, in males 1-many, distinct or confluent; anthers 2-4 celled, free or connate by means of the thickened connective, opening by a terminal pore. Ovary 1-3 celled, basilar, axile or parietal placenta; style short or long: stigma discoid or lobed. Fruit usually baccate, free or confluent. Seeds 1-many, usually embedded in a mucilaginous pulp.

### *Key to the genera.*

A. Flowers unisexual, monœcious.
- I. Floating herbs.
  - 1. Root-stocks absent.
    - (i) Leaves in close spiral, sessile, obovate-cuneate, in a rosette like tuft, bases stoloniferous . . . . . . . *Pistia*
- II. Terrestrial or marsh plants.
  - 2. Root-stock creeping.
    - (ii) Leaves usually grasslike, ovaries few, in a single whorl . . . . . . . *Cryptocoryne.*
    - (iii) Leaves broad, ovaries numerous, in several cycles . . . . . . . *Lagenandra.*
  - 3. Root-stock tuberous.
    - (iv) Leaves peltate, undivided . . . *Colocasia.*

B. Flowers hermaphrodite.
- III. Aquatic or marsh plants.
  - 4. Root-stock creeping.
    - (v) Leaves hastate, entire, pedately pinnatifid, or lobed; petioles and peduncles armed: spadix flowering downward; spathe present, ovary 1 celled . . . . *Lasia.*
    - (vi) Leaves ensiform with equitant bases; petioles and peduncles unarmed; spadix flowering upwards, spathe absent; ovary 1-3 celled . . . . . . *Acorus.*

## Genus—PISTIA

Small floating gregarious stoloniferous herbs Leaves sessile, obovate-cuneate together forming an erect cup Spathe small shortly stalked tubular below open above into an ovate concave limb Spadix adnate to the back of the spathe free above Male inflorescence of a few sessile connate stamens below the apex of the spadix cells opening by vertical slits Neuters minute connate in a ring below the males *Female inflorescence solitary ovoid conic 1 celled ovary style conic* stigma discoid placenta subparietal Fruit membranous few seeded Seeds oblong or obovoid testa minutely rugose

### PISTIA STRATIOTES Linn (Pl XVII Fig 1)

A floating water plant rarely anchoring by roots when stranded in mud generally blown about by wind on the surface of the water The plant mass is a sympodial structure but the internodes remain short and bear a tuft of leaves Roots of tufted simple white fibres clothed with fibrillae Shoots arising axillary from the sympodium stolons beside each leaf growing out along the water and developing into a new plant Leaves sessile ovate cuneate 1 4 inches long very variable in breadth apex rounded or retuse or shallowly lobulate and undulate densely closely pubescent on both faces nerves raised beneath flabelliform converging within the margin the lower side of each leaf is inflated composed of *spongy air containing fissures which serve as a float the depressed hairs* over the leaf surfaces prevent the leaves from being wetted the grooves in the leaves are provided with water pores through which like so many other aquatics excess water is eliminated from the leaf Spathe white obliquely campanulate ½ inch or more long tomentose externally gibbous and closed below contracted about the middle dilated and more or less circular above The inflorescence small monœcious with the male flowers above each with synandrium of 2 stamens female flowers below consisting of 1 carpel both are naked Ovary one celled with subparietal placenta style short slightly curved Ovate towards the stamens stigma peltate Fruit a beaked capsule Seeds many oval rugose

*Hab* Common throughout India freely floating on pools of stag *nant water having the appearance of a half grown lettuce plant* Flower ing in the hot season to the rains fruiting after the rains This plant is of the habit of *Eichornia speciosa* and multiplies rapidly by means of its stoloniferous vegetative growth It chokes up water areas and water channels which might sometimes be of such magnitude as to cause hindrance to navigation and proves difficult for eradication In a tank where both *Eichornia speciosa* and *Pistia stratiotes* are present it is *E speciosa* which gains the upper hand in the struggle for existence and the former soon replaces the latter

## Genus—CRYPTOCORYNE

Aquatic marsh or riverian herbs Stem short or absent or a creep ing root stock Leaves broad or narrow often grass like radical Spathe partly subterranean or submerged margins with a transverse septum forming

an almost closed chamber for the spadix, the tube more or less produced above the chamber and then expanding into a usually narrow, often contorted limb. Spadix very slender adnate at the tip to the septum of the spathe, male and female flowers separated by a bare region of the spadix. Male inflorescence cylindric. Stamens 1-2, distinct; anthers short, sessile, truncate, cells 2, with conical perforate tips; pollen vermiform. Female inflorescence a single whorl of connate 1 celled 4-7 ovaries at the base of the spadix mixed with a few neuters. Styles short, recurved. Fruit a fleshy berry with connate 1 valved carpels, the valves stellately spreading. Seeds many oblong; testa rugose.

### *Key to the species.*

A. Tube of the spathe longer than the limb :
  (1) Limb of the spathe densely fimbriate ciliate . . *C. ciliata*
  (2) Limb of the spathe glabrous, not fimbriate ciliate, closely twisted . . . . . . . . *C. retrospiralis.*
B. Tube of the spathe shorter than the limb :
  (3) Limb of the spathe strongly twisted, internally transversely lamellate . . . . . . . . *C. spiralis.*

## CRYPTOCORYNE CILIATA Fisch. (Pl. XX, Fig. 3.)

Perennial aquatic herbs of marshes usually submerged with tuberous creeping stoloniferous root-stock clothed with long rather fleshy fibres. Leaves 7-16 inches or more long, ¾ to 4 inches broad, radical, linear oblong or lanceolate, inequilateral, veinless somewhat fleshy, midrib stout; petiole 4-12 inches long, upper half cylindric, lower half sheathing, some spathaceous bracts surround their lower part. Spathe dull-green spotted with purple near the limb which has an ovate yellow patch near the mouth, base tubular and somewhat gibbous, tube 4-12 inches long, middle portion cylindric and convolute, limb 2-3 inches by ½ to 1½ inch in width, ovate oblong densely fimbriate, ciliate with a long, flexible, cuspidate, purple fimbrae. Scape axillary, solitary, short, somewhat compressed. Male flowers with many sessile anthers, surrounding the lower portion of the stigma. Ovaries 5-7 conical, 1 celled; style cylindric; stigma oblong, apex turbinate. Fruit long peduncled, globose, 1 inch in diameter 6 furrowed and crowned with the 6 corresponding points of the ridges. Seeds many, enveloped by a spongy substance.

*Hab.* Common in muddy creeks, ditches and on the wet banks of rivulets, ponds and wet places sometimes in salt marshes too. Flowering in the hot season verging on to the rains; fruiting later after the rains.

## CRYPTOCORYNE RETROSPIRALIS Kunth. (Pl. XX, Fig. 2.)

An aquatic herb with somewhat fleshy fibrous roots. Leaves many, radical, 3-18 inches long and ¼-¾ inch broad, lanceolate to narrowly linear, sessile, narrowed into a short rather stout petiole enlarging at the base into a sheath for those within, acute or finely acuminate, midrib slender. Spathe subsessile, nearly as long as the leaves, of a dark green colour on the outside and streaked with dark purple within; tube

narrow, longer not or scarcely twisted, limb glabrous, closely twisted Anthers many round the stigma or apex of the style, just below them are a few subcylindric glands in a verticel round the style Varies 5 6, style cylindric, stigmas orbicular Fruit a conical capsule, 5-6 valved opening from the apex Seeds a few in each cell

*Hab* In all the provinces, usually submerged herb in the bed of the rivers or along the banks not infrequently on moist marshy areas too Flowering in hot weather, fruiting later.

### CRYPTOCORYNE SPIRALIS Fisch (Pl XX, Fig 4)

A stoloniferous perennial grasslike slender herb Leaves 3 8 inches long and ⅓-⅔ inch broad, radical, linear-lanceolate, smooth, acute or acuminate, narrowed from the middle to both ends, nerves nearly parallel, petiole sheathing short rather stout Spathe subsessile, 3-5 inches long, tube very short, much shorter than the limb, linear lanceolate, at first twisted greenish outside, dark purple transversely rugose or lamellate within Ovaries 5 6, stigmas broadly elliptic Fruit a capsule 5 celled

*Hab* Common throughout the provinces, along the edges of ponds and ditches or in shallow fresh water, submerged during the rains

### Genus—LAGENANDRA

Low herbs of marshes—with creeping root-stock—which are usually annulate Leaves usually long petioled and broad Spathe tubular below, margins connate with a transverse septum forming an almost closed chamber for the spadix, limb expanded above Spadix adnate by its apex to the septum of the spathe, male and female flowers by a bare region of the spadix Perianth absent Male flowers numerous, developing into a cylindric or oblong mass towa ds the apex of the spadix Stamens 1-2, anthers sessile Ovaries numerous at the base of the spadix, spirally arranged and free or in several connate circles, 1 celled stigma subsessile, peltate or discoid, placenta basal Fruit berries free or connate Seeds 1-6 oblong furrowed

### LAGENANDRA TOXICARIA Dalzell (Pl XXI, Fig 3)

An aquatic herb with creeping [illegible] root stock Leaves 6 15 by 2-5 inches elliptic oblong [illegible] or acute, margins undulate or entire base somewhat acute or rounded; [illegible] petiole as [illegible] cle compre[illegible] inch broa[illegible] much shor[illegible] Anthers crowded yellow, the cells with tubular [illegible] Female [illegible]rescence of many ovaries in many circles [illegible] stigma sessile, pulvinate, 5 angled placenta basal [illegible] 1½ to 2 inches seeds ⅜ inch long [illegible]

*Hab* Bombay in marshes also in Ceylon.

## Genus—COLOCASIA.

Usually tall rather coarse herbs with tuberous rhizome or short stout caudex. Leaves appearing with the flowers, simple; lamina peltate ovate-cordate. Peduncles stout. Spathe with a thick convolute accrescent tube, mouth constricted, persistent limb erect, deciduous. Spadix free shorter than the spathe, appendage cylindric subulate. Flowers monœcious, male and female flowers with interposed flat neuters. Perianth absent. Stamens 3-6 connate in an obpyramidal column with angular flattened apex; anthers linear oblong. Ovaries ovoid, 1-celled, placentas parietal; stigma sessile, discoid. Fruit of small obconic or oblong berries. Seeds oblong sulcate.

### COLOCASIA ANTIQUORUM Schott. Pl. XXII, Fig. 3.)

A herb of marshes, or moist land with tubers sometimes as large as 6 inches in diameter. Leaves ovate to suborbicular cordate, peltate, semibifid at the base, 6-20 inches long, 3-12 inches wide, apex rounded and usually apiculate, basal sinus triangular, margins somewhat undulate, dark green, sometimes clouded with black, petioles stout, 3-4 feet long, green or violet or purple, inserted 1/5 or 1/3 of the blade from the sinus. Peduncles much shorter than the petioles, solitary or clustered and connate. Spathe 8-18 inches long, tube oblong, limb narrowly lanceolate, caudate acuminate, pale yellow, 2-4 times longer than the tube.

*Hab.* Common everywhere forming groups or rows along the margin of lakes, ponds, etc., or on wet soil. Sometimes the runners are very long encroaching upon the surface of a choked up tank, jheels, ponds, etc. Sometimes three varieties are recognised as noted by Roxburgh with one having leaves and petioles purple which is widely eaten; the two others generally grow on dry land—one of these two having dark purple or bluish clouds on the leaf and the other all green. The other species *Colocasia nymphaefolia* of Kunth synonymous to Roxburgh's *Arum nymphaeifolium* is rightly reduced by Hooker and Fischer to *C. antiquorum*. This *A. nymphaeifolium* which is characterised by repand leaves, peduncles and scape all of reddish colour, and by its considerably larger form is the aquatic form whose all parts are profusely eaten as curry.

## Genus—LASIA.

Stout prickly aquatic or marsh herbs with branched spinous rhizome. Leaves with long spinous petioles, leaf-blade, hastate, entire pedately pinnatifid. Peduncles long spinous. Spathe deciduous, very long, narrow, fleshy twisted base convolute. Spadix short, sessile, cylindric, obtuse, dense flowered, flowering downwards; appendage absent. Flowers hermaphrodite. Perianth 4, rarely 6 obovate, truncate segments incurved at the tips. Stamens 4-6; filaments short flat, anthers a little shorter, ovaries ovoid, 1-celled; styles stout: stigmas depressed. Fruit a cluster of obpyramidal hexagonal berries with worted or muricate tips. Seeds compressed, rugose.

LASIA HETEROPHYLLA Schott. (Pl. XXI, Fig 4.)

A stout intensely prickly aquatic or marsh herb. Leaves 6-18 inches long, radical, when young hastate or sagittate, acuminate, older often broader than long and deeply pedately pinnatifid, lobes linear elliptic or oblong-lanceolate, acuminate, smooth, shining, 1 ribbed, spinous on the nerves beneath, petiole erect 2-4 feet long, round, thickly covered with sharp prickles sheathing towards the base Peduncles as long as the petiole Spathe 8-14 inches long, erect below gaping, above the spadix twisted, leathery, dull red, purple or claret. Spadix 1-2 inches long, about 1/6 of the length of the spathe, cylindric covered all over with fructifications, claret coloured Perianth segments pink Fruit rather wedge formed berries, somewhat 4 6 sided, densely minutely muricate at the apex. Seed bilobed.

*Hab.* Common in water-logged boggy or marshy areas in most of the provinces from the tropical Eastern Himalayas down to South Burma.

## Genus—ACORUS.

Aromatic marsh herbs with creeping root-stock Leaves distichous, ensiform, bases equitant, nerves parallel Peduncles like the leaves and as long Spathe continuing the ensiform peduncle Spadix sessile, cylindric, dense flowered, flowering upwards Flowers hermaphrodite. Perianth of 6 orbicular concave segments Stamens 6, filaments linear, flat, anthers reniform Ovary conical 2-3 celled, style and stigma minute Fruit oblong few seeded berries Seeds few oblong.

ACORUS CALAMUS Linn (Pl XXIX, Fig 1)

A herb of marsh and wet places with very aromatic sympodial rhizome Leaves 2 6 feet long 2/3 to 1 1/4 inch broad, margins waved Peduncle 1/8-3/8 inch wide Spathe 6-30 inches long Spadix 2-4 inches long, 1/2 to 3/4 inch in diameter, slightly curved, free from the spathe Flowers hermaphrodite, protogynous Perianth segments 6, naked Style and stigma nearly absent. Fruit a three celled berry.

*Hab* Common in marshes as wild or cultivated, throughout India ascending 6,000 feet in the Eastern Himalayas

Another species confined to the Sikkim Himalayas and Khasia Hills is *A gramineus* Soland a much more variable plant than *A calamus*—ranging from 6 inches to 3 feet in height having shorter spathe and more slender spadix The root stocks of this " sweet flag " as it is called are used medicinally for throat trouble and obstinate cough It is also used for flavouring and protecting clothing from insect attack

## Family—LEMNACEÆ

Small or minute leafless scale like gregarious floating herbs, rootless or with thread-like roots Fronds smooth above, spongy below Flowers very minute, naked or at first enclosed in a membranous sheath Perianth absent Male flowers —stamens 1-2 with slender filament or the latter thickened in the middle or absent, anthers 1-2 celled Female

flowers:—ovary sessile, 1 celled; style short, stigma truncate or funnel shaped. Fruit a flask-shaped utricle. Seeds 1-7, testa coriaceous.

*Key to the genera.*

| | |
|---|---|
| Plants flat with roots, flowers on the margins of the plant body, stamens 1-2, anthers 2 celled . . . . | *Lemna.* |
| Plants minute granular rootless, flowers borne on the surface of the plant body, stamen 1, anthers 1 celled . . | *Wolffia.* |

## Genus—LEMNA.

Small floating aquatic herbs with roots hanging down from the underside and provided with well marked rootcap visible to the eye. The flat green floating blades are the stems (cladode). These modified stems are oval adhering by their tips, branches arising from the groove in the posterior portion under the edge. These branches may either remain attached to the parent plant or get detached and give rise to new shoots. Male flowers in pairs, one of each pair opening before the other. Stamen solitary; filaments filiform or enlarged in the middle, recurved; anthers 2 celled globose. Female flower a solitary ovary close to the male. Fruit a utricle, 1-7 seeded. Seed erect horizontal.

Lemnas are uniform group of plants commonly known as duckweeds. They are composed of flat little green fronds producing similar fronds of second order and have extremely reduced type of inflorescences. The nature of the fronds of both Lemna and Wolffia has been variously interpreted but the most accepted view is that the distal end of the frond is foliar while the proximal end is axile. The fronds developing air chambers. The roots of the Lemna are the heavier part and the tips with rootcaps evidently the heaviest. The roots are supposed to maintain the equilibrium of the plants. The plants are found floating in crowded masses forming an association on the surface of water as a thick screen of vegetation. The vegetative reproduction both in Lemna and Wolffia is predominant and they survive cold season and other unfavourable conditions by means of specialised buds termed " turions " or " winter-buds ". Flowers are rare and viable seeds are not easily available. Under favourable conditions and at the advent of warm weather the winter buds which are detached from the parent frond and sink down at the bottom after the rains begin to grow out and by the development of the air chambers the plant bodies become lighter and are lifted up to the surface and thus renew their life history. When stranded in mud they are capable of germinating. Although some of them are found throughout the season they usually appear annually during the rains, fructify in autumn, germinate in summer and after passing a dormant stage in winter reappear in the rains as floating mass on the surface of stagnant waters.

The members of Lemnaceæ has beneficial action on the foul water particularly those surcharged with organic impurities effusing bad odour. While surviving in such water, not conducive to the growth of other floating water-plants, the Lemnas purify the water by absorbing organic materials and harbouring animal life. Their sparse growth is therefore

beneficial to pisciculture Mosquito larvæ are sometimes rare in such ponds with surface screen of Lemnas But this may be due either to dearth of accommodation for the larvæ due to the plants choking up every inch of space of the surface water or to the scarcity of food materials or to the presence of the animals feeding on the larvæ imme diately after hatching It has been observed that edible fishes devour Lemnas at their young stages and in consideration of the quantity eaten up by them Lemnas appear to be one of their favourite foods in their early stage of life

### *Key to the species*

A Rootlet solitary
  I Plant body asymmetrical root sheath appendaged
    (a) fronds not tailed root-cap acute — *L paucicostata*
  II Plant body symmetrical root sheath not appendaged
    (a) fronds not tailed translucent root-cap obtuse — *L minor*
    (b) fronds tailed opaque root-cap acute — *L trisulca*
B Rootlets several
  III Plant body orbicular slightly convex often purple below — *L polyrrhiza*

### LEMNA PAUCICOSTATA Hegelm

Floating scale like aquatic annual or perennial herb Frond obovate or obovate oblong nearly flat on both surfaces asymmetrical with solitary root let appendaged root sheath and root-cap Seed erect

*Hab* Common in tanks jheels and other still waters in various parts of India Burma and Ceylon

### LEMNA MINOR Linn (Pl XIX Fig 4)

Floating scale like annual or perennial herb Frond symmetrical ⅛ ¼ inch long green above young sessile on the parent frond but soon detached with solitary rootlet Root sheath not appendaged root cap obtuse Spathe 2 lipped Stamens 2 each a male flower Style com paratively long horizontal

*Hab* Cosmopolitan herb floating in still waters in western Tibet ascending up to about 10 000 feet

Hooker mentions that Kurz considers *L minor* not an Indian species proper The writers agree with Kurz s observation and are of opinion that *L paucicostata* are frequently mistaken for *L minor*

### LEMNA TRISULCA Linn (Pl XIV Fig 2)

Submerged or floating herb ¼ ¾ inch long the tail about ½ inch long translucent thin flat elliptic lanceolate or oblanceolate connate serrate near the apex the young fronds hastate at length tailed and attenuated into a stalk by which they remain attached to the parent frond each frond giving rise to a single root fibre root cap acute Ovary soli tary Seed horizontal testa rough grooved The characteristic of this plant is that the young fronds rise at right angles from one or both sides of the parent frond and remain connected with it crosswise

### LEMNA POLYRRHIZA Linn. (Pl. XIV, Fig. 1.)

Fronds herbaceous not tailed. Floating opaque, thick, flat above, slightly convex below, ¼-⅓ inch in diameter, dark green above, usually purple beneath, 7 veined. Young fronds sessile, each frond giving rise to a tuft of rootlets, spathe 2-lipped, stamens 2. Seeds 1-2, erect.

A distinct form which is green on both the surfaces is sometimes distinguished as a variety *concolor* found in shady water areas.

*Hab.* Abundant throughout India in still waters.

### Genus—WOLFFIA.

Very minute flattish globose or conically produced below root-less herbs. Flowers inserted in grooves on the upper surface of the frond, naked, Male flowers solitary. Stamen solitary, short or long; anthers globose, 1 celled. Female flowers solitary close to the male. Ovary solitary, globose or ovoid; style short; stigma depressed. Fruit a spherical utricle. Seed globose, erect, testa thick.

### WOLFFIA ARRHIZA Wimm. (Pl. XV, Fig. 1.)

Fronds root-less, subglobose or ovate oblong convex on both surfaces. Young fronds solitary and sessile developing from the base of the frond. The most common species found floating in still waters as annual herb throughout India. The plant covers the surface of the water as thick film of green granular mass. This plant may be considered as the most minute of all flowering plants. The tiny little frond like grains of sand hardly 1/20 of an inch (1·5 m.m.) in dimension.

Another species *Wolffia microscopica* Kurz, is reported by Griffith to occur in Central Bengal and is distinguished by Kurz as a separate species by its fronds flat above and conical beneath. The writers consider that this species may better be reduced to a variety or form of *W. arrhiza.*

## Family—ALISMACEÆ.

Perennial or annual aquatic or marsh herbs. Usually erect sometimes floating often with milky juice. Leaves basal or clustered at the nodes of floating stems, with elongated petioles, sheathing but open at the base, linear lanceolate to ovate rounded often sagittate blades, entire often pellucid-dotted or lineolate. Flowers pedicellate, regular or unisexual or hermaphrodite in umbellate or paniculate whorls usually white or pink. Bracts 3 or more, membranous; bracteoles small. Perianth in 2 series, the outer of 3 imbricate, persistent, herbaceous, green and sepal like; and inner three petaloid, imbricate and deciduous, rarely obsolete. Stamens 6 rarely 3, free; anthers basifixed erect, 2-celled, extrose. Carpels free, sometimes in a single whorl, 3-6 or more, 1-celled sessile or stipitate on a flat or raised receptacle; style long, short or absent, sub-terminal or ventral; stigma simple. Fruit a bunch or whorl of achenes or follicles. Seeds small or minute curved.

## *Key to the genera*

A Fruit indehiscent of 3 or more achenes —
- (1) Flowers hermaphrodite — *Alisma*
- (2) Flowers polygamous stamens 6 receptacle flat — *Limnophyton*
- (3) Flowers unisexual stamens usually many rarely as few as 6 receptacle globose or oblong — *Sagittaria*
- (4) Flowers monœcious stamens 3 receptacle small tumid — *Wisneria*

B Fruit dehiscent of 6 7 follicles —
- (5) Flowers with petals marcescent — *Butomus*
- (6) Flowers with petals deciduous — *Butomopsis*
- (7) Flowers umbellate with thick pedicels — *Limnocharis*

The family Alismaceæ is of considerable importance from the point of evolution of Monocotyledons A Engler and E Gilg in their syllabus der pflanzen familien puts this family under the cohort Pandanales and series (Reihe) Helobie and sub series (unter reihe) Alismatineæ They consider Butomaceæ as a separate family under sub-series Butomineæ A B Rendle in his classification of flowering plants Vol I (2nd Edition), 1930, follows in general Engler's system of classification J Hutchinson of late (1934) in his book on " The families of flowering plants, Vol II Monocotyledons " advanced a step forward in his attempt to maintaining more natural affinities of the families of Monocots He places the subphylum as he calls, the Monocotyledons after Dicotyledons—supporting monophyletic origin of the Monocotyledons He thus adopts wider view of raising Butomaceæ under the separate cohort (order) Butomales and Alismataceæ under the cohort (order) Alismatales The above views are according to the modern standard of classification of flowering plants We have, as stated before, followed Bentham and Hooker's classification where they have separated all the genera under the two families—Alismataceæ and Butomaceæ under two tribes Alismeæ and Butomeæ recognising only one family—Alismaceæ

### Genus—ALISMA

Scapigerous palustrine perennial herbs Leaves lanceolate, cordate or sagittate Scapes short or long Flowers hermaphrodite, in umbellate or panicled whorls white or pink receptacle flat Sepals 3, herbaceous persistent Petal 3, membranous, deciduous Stamens 2-3 seriate, 6 or 9 filaments filiform Carpels few or many stigma small terminal Fruit of few or many, compressed or turgid coriaceous or hard achenes Seeds erect, testa membranous

## *Key to the species*

A Achenes membranous compressed
- (1) Leaves 5 7 nerved linear ovate lanceolate or sub cordate — *A plantago*

B Achenes hard and turgid
- (2) Leaves 13 17 nerved orbicular-cordate or reniform with rounded lobes and rounded or emarginate apex — *A reniforme*
- (3) Leaves 5 11 17 nerved membranous broadly ovate cordate with acute lobes and a narrow sinus — *A oligococcum*

ALISMA PLANTAGO Linn. (Pl. XIV, Fig. 3.)

A scapigerous herb of marshes. Root-stock fleshy, swollen. Leaves 6-8 inches erect or spreading, linear ovate-lanceolate or subcordate, 5-7 nerved. Scape 1-4 feet tall. Flowers ⅓ inch in diameter in panicled whorls. Fruiting sepals spreading. Petals pink or rose with a yellow claw. Style slender ventral deciduous. Achenes 20-30 inches a single whorl, membranous, compressed.

*Hab.* Common in marshes of the lower Himalayas extending from Kashmir to Manipur and Burma.

ALISMA RENIFORME Don. (Pl. XV, Fig. 3.)

A scapigerous herb of pools and marshes. Leaves 1½ to 4 inches up to 7 inches broad often broader than long, coriaceous, reniform or orbicular cordate, apex rounded or retuse, basal sinus wide, 13-17 nerved; cross nervules numerous, close, straight. Scape 1-3 feet. Bracts at the linear forks less than ½ an inch long. Flowers white pink or purple, ½ inch in diameter, in very large whorled panicles. Sepals as long as the petals, fruiting sepals persistent, at first erect, at length reflexed. Style subterminal. Achenes not whorled, 5-8 obovoid, long-awned with persistent style, dorsally ribbed, ribs smooth.

*Hab.* Common in marshes and low lands throughout the plains of India sometimes ascending up to 5,000 feet in the hills.

ALISMA OLIGOCOCCUM F. Muell. (Pl. XIV, Fig. 4.)

A scapigerous herb of pools and marshes. Leaves 3-6 inches long. 2-3 inches broad, membranous, narrowly to broadly ovate-cordate, narrowed to a blunt apex, basal sinus narrow puncate; cross nervules comparatively few and distant, not markedly, straight. Panicle 6-9 inches long and broad. Bracts herbaceous, lower large, 1-3 inches long, lanceolate, smaller upwards. Flowers white. Fruiting sepals reflexed. Style deciduous, very short, terminal. Achenes 2-6 whorled, ovate reniform, turgid, dorsally ridged, ridges tubercled.

*Hab.* Occasionally found in marshes and pools of the plans of the Punjab and Bengal.

Genus—LIMNOPHYTON.

Scapigerous palustrine perennial herbs with milky juice. Leaves sagittate, erect. Flowers polygamous, male and hermaphrodite, in panicled whorls, white. Scapes stout. Receptacle flat. Sepals three herbaceous persistent. Petals 3, membranous, deciduous. Stamens 2 seriate, 6 largest in the male flowers, filaments compressed. Carpels 15-20, obsolete in male flowers. Stigma small on a ventral style, fruit of several compressed or turgid hard achenes. Seeds erect basilar. Testa membranous.

LIMNOPHYTON OBTUSIFOLIUM Miq. (Pl. XVII, Fig. 2.)

A scapigerous erect herb of pools and marshes about 3-4 feet high. The root-stock (rhizome) is covered with slender roots and bases of

petioles. Leaves all radical 6-12 inches long and 4-8 inches broad, sometimes as broad as long, reniformly or deltoidly sagittate or triangular, acute or subobtuse or with rounded tip, basal lobes long tapering to a fine point, spreading as long as the rest of the blade, the sinus very broad, open, primary nerve 6 8 pairs, radiating from the top of the petiole, with irregular reticulate venation between them, petiole 1-3 feet long, stout, striate, chanelled above Panicle with a stout angular scape, 2-4 feet long, branches long, the lower branches usually in 4 whorls Bracts whorled broadly ovate-lanceolate, acuminate with many parallel nerves the lower reaching 1 inch long Flowers many about ½ inch in diameter, white in whorls at the nodes of the branches of panicle 4-15 inches a whorl, the upper whorls mostly male, the lower hermaphrodite, pedicels 1-3 inches long those of the male flowers more slender than the female Sepals 3 orbicular ovate, concave, ribbed, green reflexed after flowering Petals 3 broadly obovate ⅙ inch in diameter filaments 6 flattened with dilated bases Style ventral Stigma capitate, bearded or downy Achenes in a globose head ½ to ¾ inch in diameter, obovoid, turgid wrinkled Seeds bent double with 2 extremities pointing to the base

*Hab* Common in fresh water pools, marshes or running water and tanks nearly in all districts of the Madras Presidency throughout Eastern side of the Concan Bombay Bengal and Orissa

## Genus—SAGITTARIA

Erect usually perennial aquatic herbs Leaves longpetioled ellipticcordate or sagittate Flowers unisexual or polygamous in paniculate or spicate whorls Scape erect, stout or slender, sepals 3 herbaceous persistent Petals 3 membranous deciduous, white Stamens in male flower about 24 with only staminodes in female flowers or 6 10 in male flowers with 9 12 in the hermaphrodite filaments filiform compressed Carpels many crowded on the large globose, or oblong receptacle, flattened laterally ovary solitary basilar style ventral or apical, stigma papillose Fruit a globose or oblong head of flattened crested or winged achenes Seed erect, basilar, testa thin

### *Key to the species*

| | |
|---|---|
| Leaves rising above the surface of the water hastate or sagittate Stamens about 24 in male flowers reduced to staminodia in the female florets | *S sagittifolia* |
| Leaves floating broadly ovate deep cordate obtuse stamens 6 10 in male 9 12 in hermaphrodite florets | *S guayanensis* |

### SAGITTARIA SAGITTIFOLIA Linn (Pl XVII, Fig 4)

A scapigerous herb of pools and marshes with thick tuberous, stoloniferous rhizome Leaves radical 2 8 inches long very variable the first leaves of the young plants very slender and very acute, the next one or two simply cordate oblong the rest sagittate, acute smooth with more or less divergent basal lobes which are 2-3 nerved and narrower than the upper part of the blade which latter is oblong or lanceolate, acute 5 nerved, the nerves extending from the top of the petiole to the apex of

the leaf; petioles sometimes reaching nearly 2 feet long, trigonous. Scape 6-18 inches long. Flowers ½ to ¾ inch in diameter, white, often with a purple claw, in 3-5 whorls along the scape, with 3-5, usually 3, flowers in each whorl, the lower whorls female; the upper male with longer pedicels; hermaphrodite flowers are rare. Bracts nearly ovate, membranous. Sepals ovate acute much smaller than the petals. Petals large, broadly obovate. Stamens 24; filaments in the male flowers very many; absent in the female flowers; anthers sagittate. Achenes obliquely obovate, apiculate, flattened with broad, entire or subcrenate wings.

*Hab.* Common in fresh water tanks, jheels, marshes throughout the plains of India from the Punjab to Bengal and eastward to Assam, Manipur and Burma. Flowering from February to April, fruiting later.

### Sagittaria guayanensis H. B. & K. (Pl. XXIII, Fig. 1.)

A scapigerous herb of pools and marshes with fibrous roots. Leaves radical, long petioled, broadly ovate, deeply cordate, apex rounded, 1-4 inches long. 1-3½ inches wide, basal lobes rounded; petioles sheathing at the base, their length depends on the depth of the water, tapering, somewhat angular, smooth or often hairy. Scapes about as long as the petioles, often more or less hairy, 6-18 inches long, stout, ending in oblong racemes of 5-8 flowers in few approximate irregular whorls. Flowers about ⅔ of an inch in diameter, white, pedicels short stout; flowers of the lower whorls usually ternate, hermaphrodite, with 9-12 stamens, of the upper more numerous, male with 6-12 stamens. Sepals 3 herbaceous. Petals obovate erose, white. Anthers cordate at the base. Carpels compressed; style short; stigma simple. Achenes very many, surrounded by broad, prominently toothed wing.

*Hab.* Common in fresh water tanks, pools and marshes throughout the plains of India extending up to Burma.

## Genus—Wisneria.

Scapigerous marsh or water-plants. Leaves radical, long-petioled, narrowly lanceolate or oblanceolate. Flowers small monœcious, in remote involucrate whorls on a slender rachis. Involucre campanulate, truncate membranous. Sepals 3, equal, or one longer, persistent. Petals 2-4, equalling or smaller than the sepals. Male flowers: Stamens 3. Pistillodes subulate. Female flowers: Stamenodes 3, setacious. Carpels 3-6, erect, ovoid; receptacle, small, tumid; style absent or terminal short; stigma minute. Achenes and seeds subglobose or compressed; testa thin.

### Wisneria triandra Micheli.

A scapigerous aquatic herb with fibrous roots, about 1 foot high. Leaves glabrous, long petioled, longer than the scape, reaching with the petiole 9-15 inches long, the blade less than ½ an inch broad, narrowly linear—spathulate, obtusely keeled on the back; midrib stout; petioles terete, sheathing at the base, twice as long as the leafblade. Scape

erect, simple terete, 5-6 inches high, floriferous at the apex, obtusely trigonous, whorls of flowers 6-8, of which 1-2 lower consist of females, the upper males. Flowers white, usually, 3 in a whorl; pedicels short, longer than the bracts, bracts connate, sheathing obtuse. Sepals 3, linear oblong. Petals 3, shorter than the sepals. Male flowers: stamens 3, opposite the sepals; anthers didymous, filaments short. Female flowers: stigma sessile. Achenes few, subglobose or obovoid, smooth.

*Hab.* Occurring in pools, puddles and water holes of the Western Peninsula.

### Genus—BUTOMUS.

Glabrous erect perennial aquatic herbs with stout creeping rhizome. Leaves erect linear, elongate, triquetrous; blade nearly absent. Scape erect, terete. Flowers hermaphrodite, in simple, bracteate umbels. Flowers, pink, sepals and petals both coloured and persistent, coriaceous, erect. Stamens 9; filaments elongate, subulate; Anthers linear, didymous after dehiscence. Carpels 6, whorled on a flat receptacle, connate below; stigma ventral, elongate, furrowed. Fruit of 6 corriaceous beaked, many seeded follicles. Seeds linear-oblong, furrowed.

### BUTOMUS UMBELLATUS Linn.

An erect herb of marshes. Leaves 3-4 feet long, ⅓ inch broad, acuminate, base sheathing. Inflorescence a terminal many flowered, umbel. Bracts 3. Flowers 1 inch in diameter. Pedicels 2-4 inches long.

*Hab.* Occurring in marshes of the Punjab and Kashmir ascending up to 5,000 feet.

### Genus—BUTOMOPSIS.

Annual, erect, scapigerous, palustrine herbs with milky juice. Leaves radical, elliptic-acute. Flowers hermaphrodite, umbellate on a scape, longer than the leaves, whorls sometimes superposed, bracteate. Sepals 3, herbaceous, persistent. Petals 3, membranous, deciduous, white, larger than the sepals. Stamens 8-12, usually 9; 6 outer in pairs opposite the sepals, sometimes one of a pair obsolete; 3 inner single, opposite the petals, sometimes 1 or more replaced by a pair, filaments filiform; anthers oblong. Carpels 6-9 whorled on a flat receptacle, sessile, shortly connate below. 1-celled; placenta pariental, style short. Fruit of 6-7 erect membranous follicles. Seeds numerous, smooth.

### BUTOMOPSIS LANCEOLATA Kunth.

An annual variable herb of marshes and ricefields with milky juice. Rhizome small, sending out leaves above and roots below. Leaves 2-6 inches long and ⅝ to 2½ inches broad, elliptic-lanceolate, acute, membranous, quite entire, attenuated into the petiole 3-7 nerved. Scape as long as or usually longer than the leaves, stout, bearing an umbel of 3-20 flowers at its apex; bracts below the umbel scarious ½-⅝ inch long, ovate-acute. Pedicels very variable in length, 1-6 inches long

the leaf; petioles sometimes reaching nearly 2 feet long, trigonous. Scape 6-18 inches long. Flowers ½ to ¾ inch in diameter, white, often with a purple claw, in 3-5 whorls along the scape, with 3-5, usually 3, flowers in each whorl, the lower whorls female; the upper male with longer pedicels; hermaphrodite flowers are rare. Bracts nearly ovate, membranous. Sepals ovate acute much smaller than the petals. Petals large, broadly obovate. Stamens 24; filaments in the male flowers very many; absent in the female flowers; anthers sagittate. Achenes obliquely obovate, apiculate, flattened with broad, entire or subcrenate wings.

*Hab.* Common in fresh water tanks, jheels, marshes throughout the plains of India from the Punjab to Bengal and eastward to Assam, Manipur and Burma. Flowering from February to April, fruiting later.

### SAGITTARIA GUAYANENSIS H. B. & K. (Pl. XXIII, Fig. 1.)

A scapigerous herb of pools and marshes with fibrous roots. Leaves radical, long petioled, broadly ovate, deeply cordate, apex rounded, 1-4 inches long. 1-3½ inches wide, basal lobes rounded; petioles sheathing at the base, their length depends on the depth of the water, tapering, somewhat angular, smooth or often hairy. Scapes about as long as the petioles, often more or less hairy, 6-18 inches long, stout, ending in oblong racemes of 5-8 flowers in few approximate irregular whorls. Flowers about ⅔ of an inch in diameter, white, pedicels short stout; flowers of the lower whorls usually ternate, hermaphrodite, with 9-12 stamens, of the upper more numerous, male with 6-12 stamens. Sepals 3 herbaceous. Petals obovate erose, white. Anthers cordate at the base. Carpels compressed; style short; stigma *simple*. Achenes very many, surrounded by broad, prominently toothed wing.

*Hab.* Common in fresh water tanks, pools and marshes throughout the plains of India extending up to Burma.

## Genus—WISNERIA.

Scapigerous marsh or water-plants. Leaves radical, long-petioled, narrowly lanceolate or oblanceolate. Flowers small monœçious, in remote involucrate whorls on a slender rachis. Involucre campanulate, truncate membranous. Sepals 3, equal, or one longer, persistent. Petals 2-4, equalling or smaller than the sepals. Male flowers: Stamens 3. Pistillodes subulate. Female flowers: Stamenodes 3, setacious. Carpels 3-6, erect, ovoid; receptacle, small, tumid; style absent or terminal short; stigma minute. Achenes and seeds subglobose or compressed; testa thin.

### WISNERIA TRIANDRA Micheli.

A scapigerous aquatic herb with fibrous roots, about 1 foot high. Leaves glabrous, long petioled, longer than the scape, reaching with the petiole 9-15 inches long, the blade less than ½ an inch broad, narrowly linear—spathulate, obtusely keeled on the back; midrib stout; petioles terete, sheathing at the base, twice as long as the leafblade. Scape

erect, simple terete, 5-6 inches high, floriferous at the apex, obtusely trigonous, whorls of flowers 6-8, of which 1-2 lower consist of females, the upper males. Flowers white, usually, 3 in a whorl; pedicels short, longer than the bracts, bracts connate, sheathing obtuse. Sepals 3, linear oblong. Petals 3, shorter than the sepals. Male flowers: stamens 3, opposite the sepals; anthers didymous, filaments short. Female flowers: stigma sessile. Achenes few, subglobose or obovoid, smooth.

*Hab.* Occurring in pools, puddles and water holes of the Western Peninsula.

### Genus—BUTOMUS.

Glabrous erect perennial aquatic herbs with stout creeping rhizome. Leaves erect linear, elongate, triquetrous; blade nearly absent. Scape erect, terete Flowers hermaphrodite, in simple, bracteate umbels. Flowers, pink, sepals and petals both coloured and persistent, coriaceous, erect. Stamens 9; filaments elongate, subulate; Anthers linear, didymous after dehiscence. Carpels 6, whorled on a flat receptacle, connate below; stigma ventral, elongate, furrowed. Fruit of 6 corriaceous beaked, many seeded follicles. Seeds linear-oblong, furrowed.

### BUTOMUS UMBELLATUS Linn.

An erect herb of marshes. Leaves 3-4 feet long, ⅓ inch broad, acuminate, base sheathing Inflorescence a terminal many flowered, umbel. Bracts 3. Flowers 1 inch in diameter. Pedicels 2-4 inches long.

*Hab.* Occurring in marshes of the Punjab and Kashmir ascending up to 5,000 feet.

### Genus—BUTOMOPSIS.

Annual, erect, scapigerous, palustrine herbs with milky [illegible]. Leaves radical, elliptic-acute. Flowers hermaphrodite, umbellate [illegible] scape, longer than the leaves, whorls sometimes superposed, [illegible]. Sepals 3, herbaceous, persistent. Petals 3, membranous, [illegible] white, larger than the sepals. Stamens 8-12, usually 9; 6 [illegible] opposite the sepals, sometimes one of a pair obsolete; 3 [illegible] opposite the petals, sometimes 1 or more replaced by a [illegible] filiform; anthers oblong. Carpels 6-9 whorled on a f[illegible] shortly connate below. 1-celled; placenta parietal, [illegible] of 6-7 erect membranous follicles. Seeds [illegible]

### BUTOMOPSIS LANCEOLATA [illegible]

An annual variable herb of marshes and [illegible] Rhizome small, sending out leaves [illegible] inches long and ⅝ to 2½ [illegible] membranous, quite entire, atte[illegible] as long as or usually longer [illegible] 3-20 flowers at its apex; [illegible] long, ovate-acute. Pedicels [illegible]

in the same umbel. Flowers ¾ to 1 inch in diameter. Sepals 3, herbaceous, ovate or orbicular, elliptic, obtuse, reticulately veined, persistent. Petals longer, obovate white fugacious. Follicles 6-7, reticulately veined, tapering into short beaks, membranous, connate below. Seeds numerous, minute, oblong with rounded ends, dark brown, shining.

*Hab.* Common in marshes and ricefields in the plains of India up to Assam and beyond in the east.

### Genus—LIMNOCHARIS.

Glabrous scapigerous herbs with tuberous rhizome, fibrous roots below. Leaves long, thick petioled, elliptic-lanceolate or ovate-cordate, nerves few, sparse, converging towards the apices. Scapes short radical, erect, round or trigonal, or 3 sided, base sheathing. Inflorescence umbels supported by an involucre of bracts. Pedicels thick unequal. Flowers bright yellow, hermaphrodite, perianth segments 6, patent, imbricate. 3 outer sepals herbaceous, after flowering erect persistent, 3 inner petals larger, thinner deciduous yellow. Stamens numerous up to 20; filaments filiform, subulate; anthers linear basifixed, erect. Carpels 15-29, included in sepals on globose, compressed receptacle; style absent, stigma sessile. Fruits whorled or slightly connate, laterally compressed, membranaceous, semicircular. Seeds many, subquadrate, oblong; testa thick, crustaceous rather with transverse ridges.

### LIMNOCHARIS FLAVA (L.) Buch.

### VAR. INDICA Buch.

A perennial erect herb of marshes with short rather stout rhizome. Leaves erect more or less radical, sheath narrow, petiole long, leaf-blade very variable, lanceolate broadly ovate, base cuneate deeply cordate. Scape cornered, 7-15 inches long, erect. Inflorescence umbellate, 2 to 12 flowered. Pedicels about 1-1½ inch long, trigonous. Flowers about ½ to ⅔ of an inch in diameter. Sepals broadly ovate, herbaceous. Petals thinner, broadly ovate or orbicular, shorter than the sepals, yellow. Fruits semicircular. Seeds curved into horseshoe-shaped form appearing orbicular with crustaceous testa decked with transverse fimbriate ridges.

*Hab.* Common in marshes of South America, recently introduced in South Burma, Tenasserim (Mergui) where this interesting plant might have its access across the South Western border of Siam frontier. Flowering after the rains and fruiting later. It is recorded from Burma for the first time.

## Family—NAIADACEÆ.

Aquatic or marsh herbs. Root-stock tuberous often creeping. Leaves erect, submerged or floating, sheathing at the base, sometimes stipulate, entire or serrate. Flowers unisexual or hermaphrodite, green, very small, in spikes, raceme or terminal or axillary pedunculate, segments, or tubular and very delicate. Bracts small or absent. Perianth absent or of 3-4 inferior, valvate, free; or in hermaphrodite flowers solitary; or connate in male flowers. Stamens with anthers 1-2 celled.

Carpels 1-6, style long or short, stigma usually simple, sometimes stigmas 2-3 capillary Fruit various Seeds erect, pendulous or laterally peltate, testa coriaceous or somewhat fleshy.

## *Key to the genera.*

| | |
|---|---|
| A Flowers hermaphrodite | |
| (1) Perianth of sepals present carpels sessile | |
| (a) Sepals 1-3 white, pink, or pale-blue, membranous | *Aponogeton* |
| (b) Sepals 4 green herbaceous | *Potamogeton.* |
| (2) Perianth wanting carpels stipulate | *Ruppia* |
| B Flowers unisexual | |
| (c) Style long slender stigma oblique peltate achenes 2 9 male perianth wanting | *Zannichellia* |
| Style wanting, stigmas 2-4, achene solitary male perianth double . | *Najas* |

## Genus—APONOGETON

Scapigerous fresh water herbs with tuberous root-stock crowned by bunch of root-fibres Leaves oblong floating or submerged, rather membranous Flowers hermaphrodite, on long scapes bearing solitary or geminate, often unilateral spikes, which when young are enclosed in a conical quickly deciduous sheath Perianth of 1-3 equal or unequal, pink, white or pale blue segments Stamens 6 or more, filaments subulate, unequal persistent, anthers didymous Carpels 3-6, style short or absent, stigma discoid or decurrent, persistent Fruit of 3 or more coriaceous follicles Seeds erect, testa thick or thin

## *Key to the species.*

| | |
|---|---|
| A Leaves floating sepals 2 pink or white shorter than the follicles — | |
| (1) Cross nervules of leaves distinct, follicles smooth 4 8 seeded | *A monostachyon* |
| (2) Cross nervules of leaves obsolete follicles echinate 2 seeded | *A echinatum* |
| B Leaves submerged, sepals 1 3 white longer than the follicles | *A crispum* |

### APONOGESTON MONOSTACHYON Linn f (Pl XXIII, Fig 3)

An aquatic herb with stoloniferous edible root-stock Leaves floating 2½-8 inches long, ¾-1½ inch broad, oblong or linear-oblong acute or obtuse base cuneate, rounded or cordate 3-5 nerved, petioles varying with the depth of the water, often very long subtrigonous Scape varying with the depth of the water, spike solitary, 1-6 inches long, dense or lax-flowered, flowers white, pink or pale blue Sepals 2, obovate or suborbicular Stamens 6 as long as or longer than the perianth segments: anthers bluish purple Carpels 3, style subulate Follicles subglobose Seeds 1-8, oblong, 6 8 ribbed, striate

*Hab* Common in tanks, pools, low land waters throughout India Flowering during the rains and after—fruiting later

APONOGETON ECHINATUM Roxb.

A perennial aquatic herb with tuberous root-stock. Leaves floating, linear with cordate base, oblong 3-5 nerved, opaque, cross-nervules obsolete, *spike solitary, simple.* Sepals shorter than the 3 echinate 2 seeded follicles. Seeds oblong.

*Hab.* Common in shallow fresh water tanks of Central Bengal and Northern Circars.

Roxburgh in his Flora Indica, p. 310, describes this species having "seeds about six". *But this has not been shown in his figures.* This is evidently through oversight. The species is diagnosed by its echinate follicles containing 2 seeds in each as correctly illustrated in the enlarged sketches of Roxburgh's Icones.

APONOGETON CRISPUM Thunb. (Pl. XXIII, Fig. 2.)

A perennial stoloniferous aquatic herb with tuberous edible root-stock. Leaves *1-3 feet long, radicle, petioled, submerged, lanceolate, waved,* base rounded or cordate, 3-7 nerved, membraneous translucent, cross-nervules distinct, compressed shorter than the leaves. Scapes, round, *smooth, the length varying with the depth of the water,* thickening as it ascends. Spikes 3-5 inches long, simple, solitary, densely or laxly flowered. Sepals white, obovate spathulate, very variable in size, much longer *than the 3-4 smooth 1-2 seeded smooth oblong,* beaked, follicles. Seeds oblong smooth.

*Hab.* Common in fresh water tanks, pools and low land water throughout India.

Genus—POTAMOGETON.

Aquatic submerged herbs with creeping root-stock. Leaves submerged or floating, opposite or alternate, entire or toothed. Stipules interfoliaceous. *Flowers minute, hermaphrodite, spicate* on a short or long axillary or leaf-opposed peduncle arising from a sheath, bracts absent. Perianth of 4 concave green valvate segments. Stamens 4; anthers sessile at the base of the segments of the perianth, didymous. Carpels 4, free sessile; stigma subsessile or decurrent, persistent. Fruit of small coriaceous or spongy drupelets. Seeds subreniform.

*Key to the species.*

A. Upper or all leaves floating . . . . . . . . *P. indicus.*
B. Leaves all submerged :
  (1) Leaves lanceolate, membranous . . . . . *P. Crispus.*
  (2) Leaves narrowly, linear *filiform* opaque . . . *P. pectinatus.*

POTAMOGETON INDICUS Roxb.

An aquatic, submerged, rooted herb with upper or all the leaves floating. Stem terete, branched, smooth, its length varying with the depth of the water. Leaves petiolate; the upper floating leaves 2½ inches to 4 inches long 1-1½ inch broad, alternate or uppermost opposite, oblong or elliptic-lanceolate, acute obtuse or acuminate, thinly coriaceous,

opaque, glossy, many nerved, base acute or rounded, the petioles varying in length with stipules 1-1½ inch long, free, the lower submerged leaves reaching 8 inches long, membranous, undulate, with petioles shorter than the blade Peduncles axillary or leaf opposed 1-2 inches long, stout or slender, not thickened upwards Spike 1½ inch long dense flowered green Sepals 4 clawed the claw as long as the limb, limb suborbicular concave Drupelets ⅛ inch long, obliquely truncate, shortly beaked

*Hab* Common in fresh water areas throughout the plains of India ascending up to 9,000 feet in the Sikkim Himalaya Flowering in November to December, fruiting later

### POTAMOGETON CRISPUS Linn

Aquatic herb with branched compressed somewhat dichotomous stem Leaves 1-3 inches long ⅛ to ⅜ inch broad, all submerged, semiamplexicaule linear or linear oblong obtuse with crisped and finely serrulate margins 3 nerved translucent stipules small caducous Peduncle long often curved, tapering upwards Spike ¼ to ⅓ inch long, few flowered, flowers small Sepals clawed limb suborbicular Drupelets obliquely obovoid 1/8 to 1/5 inch long terminated by slightly recurved compressed beak, ribs entire or toothed

*Hab* Common in fresh water tanks pools and other water areas throughout the plains of India reaching sometimes in the region of the Temperate Himalayas extending from Kashmir to Bhutan down to Munipore across the Naga Hills towards Burma

### POTAMOGETON PECTINATUS Linn

Aquatic herb with filiform rather profusely branched stems forming with the leaves tassel like masses when lifted out of water Leaves all submerged, alternate 1-8 inches long 1/20 to 1/5 inch broad, narrowly linear or filiform acute opaque 1-3 nerved or the lower sometimes 5 nerved, stipules adnate to the leaf sheaths the tips free Peduncle with the spike 2-3 inches long not thickened upwards, flowers few in few distant whorls, minute green Sepals suborbicular Drupelets ⅛ to ⅙ inch turgid dimidate obovoid slightly compressed shortly beaked rounded and obscurely 3 keeled on the back with a very short straight beak

*Hab* Common in fresh water pools and low land waters throughout the plains of India penetrating into Tibet ascending sometimes from 12 17 000 feet altitude

### Genus—RUPPIA

Aquatic herbs of brackish water with slender submerged much-branched stems and creeping root stock Leaves alternate or subopposite, long filiform with stipule like sheaths Flowers minute, hermaphrodite 2 6 together within a leaf sheath on an ultimately elongating straight or spirally coiled peduncle Perianth absent Stamens 2 anthers sessile or 2 celled Carpels 4 stigma sessile peltate Fruit of 4 stipulate ovoid obtuse or beaked achenes Seeds uncinate pendulous

G 2

RUPPIA MARITIMA Linn.

A submerged aquatic herb plentiful in brackish water forming tangled masses of filiform leafy flaccid stems and branches; stem, 2 feet long or more. Leaves filiform 1-4 inches long dull olive-green. Peduncles ¼ to 1 inch long, not spirally coiled. Flowers minute in pairs, enclosed in a leaf-sheath. Stipes of carpels rapidly elongating after flowering, reaching 1-6 inches in length, spreading and forming an umbellate head of achenes. Achenes obliquely ovoid, acutely beaked.

*Hab.* Common throughout India in brackish water.

C. E. C. Fisher in his "Flora of Madras", Part IX, p. 1600, distinguishes a subspecies *spiralis* Linn. This subspecies is characterised by its peduncles long and spirally twisted. Such a separation of "spiralis" raising it to the rank of a subspecies has also been hinted by Reichenbach in his Iconographia Botanica Seu Plantae Criticae.

J. D. Hooker in the Flora of British India, Vol. VI, p. 568, 1894, has described one species of *Ruppia*—*R. rostellata* Koch. This specific name has subsequently been adopted by Prain and Cook in their floras of Bengal and Bombay. The authority quoted in Hooker's F. B. I. is Reichenbach. These authors evidently follow Reichenbach's views of recognising *R. rostellata* Koch and *R. maritima* Linn as two distinct species. Such a recognition as noted by H. G. Ludvico Reichenbach in his Iconographia Botanica Seu Plantae Criticae is based on the characters of the stigmas and the stipuliform basal membranous sheaths of the leaves. The marked oblique shape of the style and stigma of *R. rostellata* and erect style and stigma of *R. maritima* besides other minor differentiating characters of spikes, stipular sheaths of *R. maritima,* are undoubtedly sufficient distinctive characters which justify Koch to distinguish the two plants as two separate species as mentioned by him in his Litt. Dat. de 23rd February 1824. Such a distinction is hinted in considering *R. rostellata* as a variety of *R. maritima*—Var. *minor* as described by Mert. et. Koch, Deutschl, Flora I, p. 861. This Var. *minor* is therefore considered by Reichenbach as a synonym of *R. rostellata.*

C. E. C. Fisher in the Flora of the Madras Presidency, Part IX, p. 1600, 1931, evidently does not recognise such a specific rank of *R. maritima* Var. *minor*—*R. rostellata* Koch. The latter name therefore has been considered by him as synonymous to *R. maritima* Linn as described by Linneaus in his Species Plantarum—1753. Considering wide variations in aquatic plants Fischer's decision of considering *R. rostellata* as a subspecies under the authentic Linnean species *R. maritima* appears to be more accurate in the light of the latest rules of nomenclature. The authors therefore here differ from Hooker and others and adopt *R. maritima* L. as the correct specific name.

Genus—ZANICHELLIA.

Aquatic brackish or fresh water submerged herbs with slender stem and root-stock. Leaves linear with stipular sheath. Flowers minute monœcious, both the sexes in one membranous sheath. Male flowers: Perianth absent. Stamen solitary, filament filiform, anther linear 2-3

celled Female flowers Perianth cupular, hyaline Carpels 2-9, sessile, style rather long, slender, Stigma oblique, peltate Fruit sessile or stalked subreniformly incurved achene usually 4 in number. Seeds pendulous, testa thin.

### ZANNICHELLIA PALUSTRIS Linn

Stem very slender filiform Leaves 1-3 inches long all submerged, alternate or opposite, narrowly linear or filiform Flowers minute, subsessile enclosed in the leaf-sheaths Filaments of the male flower at first short afterwards elongating Drupelets distinctly stipitate, compressed sausage shaped, subreniformly incurved, beaked, crested on the back

*Hab* Common in salt marshes and less commonly in fresh water throughout India ascending up to 15,000 feet in Western Tibet

*Four or five forms of this species are sometimes found due to its* variati ns in the wide range of its occurrence in different localities and elevations in both the temperate and subtropical regions

### Genus—NAJAS

Aquatic submerged herb growing in brackish water with branched filiform smooth or muricate stems rooting at the nodes Leaves sessile opposite alternate or whorled narrowly linear sinuate-dentate or serrulate Flowers minute, axillary, monoecious or dioecious Male flowers Perianth double, the outer tubular or inflated, entire or 4 fid, the inner hyaline Stamen solitary, adnate to the inner perianth tube, anther apiculate or cuspidate, 1-4 locular, Female flowers Perianth absent or hyaline or adnate to the carpel Carpel solitary, sessile Fruit an oblong achene Seed erect, testa very thin

### *Key to the species*

| | |
|---|---|
| A Male and Female flowers in spathe | *N Indica* |
| B Male flowers only in a sheath | |
| (1) Anther 1 locular | *N Minor* |
| (2) Anther 4 locular | *N foveolata* |
| C Male and female flowers unprovided with a sheath | *N graminea* |

### NAJAS INDICA (Wild ) Cham

A slender aquatic herb with lax tenuis often filiform stem Leaves about 1-1¼ inch long, narrowly linear, margin with 10-17 large teeth—often as long as or longer than the leaf-width and consisting of subequilateral or obtusely triangular projections of the margin ending in a spine Sheath narrow 1/12-1/8 inch or slightly more in length, upper margin variable, auricled or subtruncate, broadly rounded or dentate Male flowers about ⅙ inch long, spathe narrowed above into a slender neck ending in an irregularly toothed mouth which is generally drawn out into two opposite long linear prolongations ending in one or two spines Perianth fitting closely to the ellipsoidal anther and meeting above its apex in two thickened lips Female flowers about the same length those of the male flowers Spathe passing above into a neck of

¼ to ⅓ inch its whole length, the mouth bearing short brown spines. Style cylindrical ending in two unequal stigmas one of which protrudes out of the perianth. Fruit ellipsoid 1/12 inch long enclosed in the persistent spathe. Seeds yellow or brown with 20-30 rows of well-marked fairly isodiametrical areolæ which rapidly become narrower on and near the raphe.

*Hab.* Common in the water areas of Bengal, Bihar and Madras Presidency.

### NAJAS MINOR Allioni. (Pl. XXIII, Fig. 4.)

A small aquatic fragile herb about 1¼ to 10 inches high, slender much dichotomously branched; internodes vary in length, short, smooth. Leaves ⅜ to ⅞ inch long, scarcely 1/20 inch wide, narrowly linear tapering the upper recurved with 6-12 spreading teeth on each margin, sheaths broad truncately rounded often asymmetrical with 5-7, prominent teeth on each shoulder. Flowers fasciculate, monœcious, the male and female often found in successive leaf axils protected by the leaf sheath. Male flowers about 1/16 inch long. Anthers 1-celled. Female flowers about 1/16 inch long. Ovary sessile, style long almost cylindrical or slightly tapering, ending in two unequal stigmas. Fruit 1/12-1/8 inch long. Seeds narrowly ellipsoid, with 12-18 longitudinal rows of transversely elongated ladder like pits.

*Hab.* Common throughout India and South Burma in stagnant fresh waters.

### NAJAS FOVEOLATA A. Br.

Plants 6-8 inches or more tall with spreading stems more or less dichotomously branching. Leaves linear ascending or the lower spreading, larger with short lines running horizontally towards the margin with ascending small subtriangular slender short spine on both the sides, with 6-10 on each side. Sheaths about 1/10 of an inch long or slightly more in length, more or less setlaceous, auricled, auricles furnished with 4-6 spiny teeth above and on the outer edge. Male and female flowers on the same shoot, about 1/10 inch long. Spathe ellipsoidal ending in a cylindrical beak, ¼ to ⅓ of the whole length ending in a fringe of slender sharp spines. Male flowers: Perianth bilabiate, closely fitting to the anther. Female flowers: naked and sessile, one of the stigmas often terminating in a brown spine. Fruit about 1/10-1/12 inch long. Seeds marked with about 20 rows of quadrate to polygonal pits.

*Hab.* Common in most of the provinces particularly in Bengal and Assam and extends towards Burma and Malaya.

The Burma specimen as those of the Inle Lake, Burma, is generally covered with calcium encrustation like those of the algal species "chara" of similar habit. The Calcutta jheels are frequently a favourite resort of this plant. It grows in masses forming either pure society of its own or mixed societies with Ceratophylum demersum and Hydrilla verticillata —the other two common submerged species.

### NAJAS GRAMINEA Del

A more slender delicate bright green plant of grass like habit rooting at the nodes The shoots varying in length from 2 inches to 2 feet and over Lateral branches sometimes very short forming a densely leaved tangle and occasionally due to shorter internodes the plant is of cylindrical habit Leaves about ½ inch to 1 inch long, linear, spreading, recurved Sheath 1 in to 1½ inch long with the auricles—furnished with about 10 small teeth on both inner and outer edge Marginal teeth 30 50 in number consisting of sharp ascending 30-50 spines Flowers borne on the short lateral shoots often several at the same node Male flowers Perianth directly above the anther in 2 rounded ear like lobes The flower stalk elongates before dehiscence becoming as long as the anther Female flowers slightly longer than the male which are minute about 1 m m in length Fruits solitary of 2-4 crowded together at the base of the dwarf shoots, narrowly oblong or narrowly ellipsoidal oblong, tapering more at the tip in the fresh specimens greenish brown with fleshy pericarp, in dried specimens the pericarp membranous, peeling from the yellowish brown seed Seeds about 1/12 inch long, testa more or less distinctly marked with 25 30 somewhat regular rows of small subquadrate areolae

*Hab* Common throughout India in stagnant fresh water The densely leaved lateral shoots and tips of main shoot give a graceful plumose habit It is easily distinguished from *N minor* by its ½ 1 inch long usually whorled broader more transparent and more acutely toothed leaves

## Family—ERIOCAULEÆ

Annual or perennial scapigerous, marsh, rarely aquatic low herbs Leaves usually crowded narrow, linear lanceolate, grass like, with sheathing bases Flowers unisexual monoœcious, mostly white usually densely aggregated in a solitary globose or hemispheric head at the apex of a long peduncle with a tubular basal sheath Heads androgynous, rarely unisexual with an involucre of short 2 many seriate, imbricate, scarious or chartaceous bracts often radiating beyond the circumference of the flowering part of the heads the florets often more or less hoary with short white hairs and closely packed on a flat, convex hemispheric or conical receptacle, each floret solitary in the axil of a cruciform bract which equals or exceeds its floret and is usually dorsally hairy near the apex Male flowers stipitate Sepals 2 or 3 free or more or less connate or spathaceous and split down on one side, equal or often one smaller and differently shaped sometimes winged on the back Petals usually united into a cylindric or funnel shaped lobed or truncate tube, one lobe sometimes much larger than the rest rarely free, each lobe usually bearing a black subapical gland Stamens 4 6 usually in 2 series filaments filiform anthers usually 2 celled usually black or bluish black sometimes white or yellow Female flowers sessile or stipitate, sepals usually free rarely more or less connate usually 2 or 3 rarely 1 or absent petals 3 free rarely absent usually pilose and bearing a black gland at the apex Ovary superior, sessile or shortly stipitate 2-3 celled Style single usually short stigmas as many as the cells of the ovary,

usually long and single sometimes bifid. Fruit a small membranous 2-3 celled loculicidal capsule. Seeds pendulous, minute, oblong, ellipsoid or globose; testa thin often with rows of white papillae smooth or reticulate and often more or less ribbed.

## Genus—ERIOCAULON.

Marsh or aquatic herbs. Stem usually very short or absent. Leaves linear, membranous often fenestrate. Male and female flowers generally mixed in the same, rarely in separate heads. Peduncles often twisted, glabrous or hairy. Male flowers: Sepals 2-3, free or often more or less united into a split spathe. Corolla lobes, 2-3, always present, though often minute, 1 often enlarged and sometimes protruding beyond the floral bracts, usually bearing an apical black rarely red gland on the inner face. Stamens twice as many as the petals or by abortion fewer. Anthers 2 celled usually black. Female flowers: Sepals usually free, mostly unequal, concave, boatshaped or flattened, often bearded on the apical part or ciliate. Petals 2-3 always free, rarely absent, often with a black gland on the inner face a little below the apex.

### *Key to the species.*

A. Receptacle glabrous or sparsely hairy:—

(1) Involucral bracts oblong, obtuse passing gradually into the oblong—lanceolate, subacute scarious floral bracts under pale whitish or purplish heads; leaves opaque or translucent . . . . . *Sieboldianum.*

B. Receptacle Villous:—

(2) Involucral bracts at length reflexed under the globose grey or snow-white heads; leaves reddish often semitranslucent . . . . . . . . *Quinquangulare.*

(3) Involucral bracts reflexed under dark grey globose heads; leaves grey-green, opaque . . . . *Trilobum.*

### ERIOCAULON SIEBOLDIANUM Sieb and Zucc. (Pl. XXV, Fig. 1.)

A tufted annual marsh herb about 6 inches in height. Leaves 1-2½ inches long, 1/30-1/10 inch broad, narrowly linear subulate glabrous, opaque or translucent, few-nerved. Peduncles numerous, aggregated, glabrous, 3-6 inches high, slender 5 ribbed; sheaths 1/5 to 1 inch long obliquely split, glabrous, shorter than the leaves. Heads small 1/8-1/5 inch in diameter, whitish or purplish, globose or ovoid; involucral bracts 1/10-1/8 inch long, the outer oblong, obtuse, the tip often lacerate, the inner narrower, all scarious, spreading or ascending, glabrous, pale; floral bracts 1/10-1/8 inch long, linear oblong or oblong lanceolate obtuse or subacute, closely imbricating, byaline glabrous, shining often with a board central purplish band; receptacle columnar, glabrous or nearly so. Male flowers stipitate. Sepals connate into a glabrous cucullate spathe, split in front, three-toothed at their apex. Corolla tube 1/30 inch long. Petals minute narrow, subequal. Stamens 6, anthers rotund, white. Female flowers stipitate. Sepals usually 2 free, narrowly linear, acute, hyaline, glabrous, deciduous. Petals absent. Ovary stipitate, 3 lobed, style branches 3, filiform. Seeds very small ellipsoid, smooth.

*Hab* Common in rice-field and marshy ground throughout India extending from Kashmir down to Burma and southward to Ceylon

ERIOCAULON QUINQUEANGULARE Linn (Pl XXV, Fig 3)

A herb of marshes with leaves 1-4 inches long and 1/10 to 1/3 inch broad, linear attenuated towards the apex, acute or acuminate, glabrous, flat membranous, fenestrately 5-11 nerved, opaque or sub translucent, green above, often purplish beneath frequently drying red Peduncles many 1-11 inches high glabrous 5 ribbed, scarcely twisted Sheaths 1-2¼ inches long obliquely split glabrous, often purplish obtuse lax, shorter than the leaves Heads globosely ovoid ⅙-¼ inch in diameter, grey or snowwhite, involucral bracts 1/12 inch long, linear oblong or obovate oblong, subcuneate at the base, very obtuse, scarious, glistening, eventually reflexed and concealed under the heads, floral bracts 1/10 inch long sub rhomboid, obovate or oblanceolate, acuminate or cuspidate dark or plate, hairy near the apex Receptacle globose or columnar, sparsely pilose Male flowers Sepals 3, all or 2 only connate into a spathe, oblong spathulate obtuse, apex white, papillose hairy Corolla lobes linear, apex papillose hairy, with or without a black gland Stamens 6, anthers black Female flowers Sepals 3, free, linear spathulate obtuse hyaline or nearly so, apex hairy, white Petals 3 free linear spathulate or narrowly oblanceolate villous apex with a black gland Seeds very small, oblong ellipsoid pale brown, smooth or with a few transverse striae

*Hab* Common in rice-field or marshy areas throughout India from the upper Gangetic Plain to Burma and southward to Ceylon

ERIOCAULON TRILOBUM Buch Ham

A small tufted herb of wet places Leaves erect cæspitose green, 1¾ to 4½ inches long and 1/10-¼ inch broad, narrowed towards an acute or subobtuse apex, glabrous, flat fenestrately 9-11 nerved not drying red Peduncles many, 3 8 inches high glabrous 5 6 ribbed twisted Sheaths 3/4 2 inches long obliquely split, somewhat lax, striatulate Heads 1/8 1/5 inch in diameter subglobose, dark grey Involucral bracts 1/8 inch long and 1/20 inch broad, linear oblong obtuse glabrous, at first radiating beyond the head afterwards reflexed, pale, shining floral bracts 1/12 inch long, cuneate obovate obtuse or sub acute but not acuminate ciliate at the apex concave receptacle villous Male flowers shortly stipitate Sepals 3 oblong obtuse connate into a spathe, glabrous Petals minute Stamens 6 anthers black Female flowers subsessile Sepals 3 oblanceolate, boat shaped hairy on the back Petals 3 free, narrowly spathulate hairy above and with a black gland Ovary subsessile, 3 lobed style branches 3 filiform Seeds very small ellipsoid microscopically, closely transversely ridged pale yellow

*Hab* Common in rice field and marshes throughout India ascending 4 000 feet in the Kumaon hills and extending down to Bengal the Concan and Malabar

## Family—CYPERACEÆ.

Grass like annual or perennial herbs of damp and marshy habitat with fibrous roots and short or long often scaly creeping rhizome. Stems usually solid terete or often 3 angled. Leaves usually in a basal tuft or crowded on the lower part of the stem, with closed or open sheath at the base and narrow grass like blade rarely the blades entirely reduced. Ligule very rare. Inflorescence of solitary, fasciculate umbellate, paniculate or spicate spikelets composed of small distichously or spirally imbricate scales (glumes) subtended by one or more usually leaflike or a little broader involucral bracts. Flowers minute hermaphrodite, unisexual and monoecious very rarely dioecious arranged in small spikes (spikelets) and each usually solitary within a bract (glume); bracts (glumes) distichously or spirally arranged; rarely the female spikelets reduced to one bract and one flower. Perianth reduced to scales, bristles or hairs, very rarely subpetaloid, often absent. Stamens 1-3, very rarely more or numerous; filaments free; anthers basifixed, oblong or linear apex sometimes crested. Ovary superior 1-celled; style with 2-3 slender branches or 2-3 toothed rarely entire or nearly so; stigmas 2-3. Fruit nut like compressed, indehiscent, that from 2 lobed style often more or less 2 sides, that from a 3 lobed style often 3 angled. Seed erect, free.

### *Key to the genera.*

A. Flowering glumes all distichous :—
- (1) spikelets many flowered . . . . . . . *Cyperus.*

B. Flowering glumes spirally imbricate :—
- (2) style base swollen . . . . . . . . *Eleocharis.*
- (3) style base not swollen . . . . . . . *Scirpus.*

## Genus—CYPERUS.

Perennial or annual erect or floating glabrous herbs with creeping rhizome. Leaves mostly towards the base. Pedicel flat or terete and channelled, occasionally reduced to sheaths. Spikelets in solitary globose or umbellate heads or spikes. Involucral bracts one or more foliaceous; bracteoles under the secondary divisions of the inflorescence; rachilla often winged usually persistent. Spikelets linear or oblong, Glumes distichous, the two lowest empty, those above hermaphrodite, all nearly equal, deciduous from below upwards the uppermost 1-3 sterile or empty. Stamens 1-3; anthers linear oblong. Ovary compressed; style short or long or obsolete; stigmas 2 or 3. Fruit a nut, trigonous, triquetrous, obovoid or plano-convex.

### *Key to the species.*

(1) Plants floating in water, spikelets green, marked with red or chestnut numerous, congested in a single head, style long undivided or obscurely 3-2 toothed . . . . *C. Cephalotes.*

(2) Middle sized plants of marshes, spikelets green, reddish brown, narrowly linear, almost filiform, spreading stellately, glumes very distant, reddish brown . . *C. distans.*

(3) Tall herbs of marshes. Spikelets pale straw coloured, bracts short, glumes approximate . . . . . *C. tegetiformis.*

(4) Spikelets bright brown, red brown or chestnut, much compressed, ascending, wings persistent green or pale . *C. exaltatus.*

CYPERUS CEPHALOTES Vahl.

A floating glabrous herb with slender stolons Leaves 2-5, as long as 2/3 of the erect stem, about 1/6 inch broad Bracts 3-5, up to 4-8 inches leaflike Inflorescence of one compound dense head. Spikelets many, compressed rigid, often bent, 10-36 flowered, rachilla stout, persistent, angular, hardly winged Glumes closely packed, boat-shaped, green, more or less marked with red or chestnut. Stamens 3-2, filaments broadly ligulate, anthers large, linear-oblong, multicous Fruit a nut 1/2 the length of the glume, ovoid, unequally trigonous that is somewhat plano convex, passing gradually into the linear style, 2/3 the length of the nut, stipitate below, corky This lower corky thickening of the cells enables them to float and vegetate among the surface vegetation of tanks

*Hab* Common glabrous sedge found floating in tanks extending from Bengal to Burma

CYPERUS DISTANS Linn f (Pl XVI, Fig 4)

Glabrous herb with stolons clothed by dark brown elliptic, acute scales Stems 1-3 feet high Leaves often as long as stems Inflorescence a large compound umbel 8-12 inches in diameter From a single head 2½ in diameter to an umbel with one ray 26 inches, copiously 3-4 times compound Bracts rather longer than umbels, leaflike Rachis of spike 1/3 to 2 inches glabrous Spikelet young nodding, mature spreading at right angle, more or less red, spicate narrow-linear, 10-20 flowered wings of rachilla narrow hyaline, ultimately caducous, glumes remote oblong-elliptic obtuse, stamens 3, anthers oblong muticous Nut dusky black, oblong or narrowly ellipsoid 1/4 to 3/5 the length of the glume, style much shorter than nut, branches shortly exsert

*Hab* Common sedge all over the warm parts from the sea-level to an elevation of 3,000 feet in the Himalayas

The species is characterised by slender racheola of spikelet appearing wavy due to distant scars of the fallen glumes

CYPERUS TEGETIFORMIS Roxb (Pl XXVI, Fig 4)

Perennial herb with tuberous, root-stock, erect stem about 4 6 feet high, three cornered, transversely septate, smooth, bright-green, naked Leaves hardly any enveloping the base of the erect stem the uppermost often ending in a short ensiform leaflet Involucres 3-4, sublanceolate, erect about 1/4 the length of the umbel, involucels chaffy Umbels decompound and supercompound, smooth compressed, peduncles of various length Spikelets alternate, subulate, of bright brown colour, each bearing from 20 30 flowers Stamens 3 style 3 cleft, seed oblong, compressed without angles

*Hab* A tall glabrous rush like sedge in moist areas in Bengal, Assam and Madras

CYPERUS EXALTATUS Retz

Perennial herb with fibrous roots and erect stem 3-6 feet high 3 sided with rounded angles and hollowed sides Leaves mostly radical

sheathing, sometimes as long as the erect stem. Umbel decompound, spreading about 6 inches each way. Umbellets 2 or 3 subsessile, and from 5-10 on pretty long peduncles of unequal lengths; they are composed of small partial short-pedicelled umbellets of 3-6 linear, compound cylindric, spikes, consisting of numerous small sessile 3-8-20 flowered simple alternate, many, brightly coloured, spikelets. Involucre 3-6 leaved, unequal. Glumes (even in fruit) closely imbricate, wings of rachilla oblong, persistent. Anthers oblong not exserted. Seeds 3 sided, smooth.

*Hab.* A large glabrous sedge, common in most of the provinces, in marshy areas, sides of water courses and wet soil.

### Genus—ELEOCHARIS.

Glabrous herbs with tufted simple erect stems embraced by one or more membranous cylindric truncate sheaths below. Leaves obsolete or rarely a herbaceous or membranous limb on the sheath. Inflorescence a single, solitary ovoid or cylindric many flowered spikelet. Glumes imbricate round the rachilla, membranous or coriaceous, the lowest usually empty or bract-like but not longer than the spikelet; the uppermost absent, retrorsely scabrous or spinulose. Stamens 3-1, anthers linear or linear oblong, crested, muticous, or with an acicular tip. Ovary orbicular, ovoid, style with a swollen base; stigmas 2-3, filiform or flattened. Fruit a plano-convex or trigonous nut, crowned by the persistent, much swollen, pyriform, conical or depressed style-base.

*Key to the species.*

A. Glumes subrigid; styles 2-3 fid.
- (1) Nut smooth . . . . . . . . . . *plantaginea.*
- (2) Nut striate . . . . . . . . . . *Fistulosa.*

B. Glumes membranous; stigmas 2 fid.
- (3) Rhizome short or absent . . . . . . . *Capitata.*
- (4) Rhizome creeping, present . . . . . . . *palustris.*

ELEOCHARIS PLANTAGINEA R. Br. (Pl. XXVII, Fig. 2.)

A rather tall herb with 1-3 feet high stem, densely tufted, transversely septate when dry. Sheaths 2-8 inches long, often torn, shining bright red-brown. Spikelet straw coloured, rather narrower than the stem; rachilla stout, angled, with irregular broad concave facets between the insertion of the glumes. Glumes closely imbricate, subrigid, concolourous, not keeled, broadly ovate, obtuse rarely truncate, 1 nerved, coriaceous, persistent, the lowest very stout appearing as a continuation of the stem. Bristles 7, equalling or exceeding the nut, retrorsely scabrid, yellow. Stamens 3, anthers narrowly linear, with a long setaceous tip. Style long, flattened with a triangular base; stigmas 3. Nut orbicular obovoid, compressed, smooth, yellowish.

*Hab.* Common in most of the provinces from sea-level to 3,000 feet extending to the Malayas through Burma.

ELEOCHARIS FISTULOSA Link. (Pl. XXII, Fig. 1.)

A tall stout rush-like sedge, with 1-3 feet high stoloniferous robust or slender stems, triquetrous under the spikelet, concave on one face, not transversely septate. Sheaths obliquely truncate, thinly membranous,

loose, ending in an ovate, acute or lanceolate hyaline limb Spikelet long as broad as the stem or broader, greenish, lowest glume bractiform, broadly ovate coriaceous, with narrow membranous margins Rachilla slender, angular, with broad concave facets between the glumes Fertile glumes, ovate-oblong or subobovate, multistriate on the back outside, often with minute black spots inside, bristles longer than the nut, brown, retrorsely scabrid Stigmas 3, nut long obovoid, striate, pale, tipped with annular somewhat saucer shaped style-base which is about ¾ the width of the nut

*Hab* Common in swamps from the sea-level to 3,000 feet extending from the Nepal to Burma down to Ceylon

ELEOCHARIS CAPITATA R Br

A slender annual herb with densely tufted trigonous 2-10 inches high stems Leaves absent Sheaths short, sometimes tinged with purple, the mouth oblique, acute Spikelets globosely ovoid, rounded at the apex, pale Lowest glumes, bractiform, ovate oblong obtuse, fertile glumes orbicular, ovate, obtuse, imbricate, easily detached, concave Rachilla terete, pitted bristles longer than the nut, 7 or fewer pale rose-brown when ripe, retrorsely scabrid Anthers small linear obtuse Style short, stigmas 2 Nut globosely obovoid, brown, smooth, shining, apiculate with the broad style base

*Hab* Common in the rice-fields and moist sandy localities from sea-level to 2 000 feet stretching over the plains of Burma and Ceylon

ELEOCHARIS PALUSTRIS R Br

A rather variable plant with creeping black or chestnut brown rhizome rooting at the nodes, aerial stems 4-24 inches tall Uppersheaths truncate or sometimes produced at one side into a small triangular limb Spikelets ellipsoid or cylindric, chestnut brown or straw coloured, sub acute, the lowest glume bract-like, empty suborbicular, smaller than the fertile ones, coriaceous with hyaline margins surrounding about half of the stem Bristles usually 4, longer than the nut, scabrid brown Fertile glumes thinly membranous either hyaline except the back, which is narrow and green ovate lanceolate, obtuse or subacute or elliptic acute, with the back and sides chestnut brown and with hyaline margins Stamens 3, style above the conical base, stigmas 2 about as long as the style Nut globosely obovoid, smooth biconvex, bright yellow or pale brown, the margins scarcely thickened

*Hab* A more or less cosmopolitan species extending in the western Himalaya up to about 12 500 feet

Genus—SCIRPUS

Annual or perennial herbs, glabrous or the inflorescence slightly hairy Leaves narrow, arising from the base or a little higher Rhizome creeping or absent Inflorescence terminal or lateral of 1 to many spikelets in clusters or umbels or corymbs Spikelets usually many flowered Glumes spirally imbricate, rarely subdistichous below Few of the lowest glumes (1-3) empty and few of the uppermost shrivelling up, the

intermediate with hermaphrodite flowers. Bristles either absent or 1-7, usually linear, sometimes broad, retrorsely scabrid, rarely plumose. Stamens 1-3 anterior. Ovary obovoid, style slender, base not dilated, continuous with the nut. Stigmas 2-3. Fruit a nut sessile or nearly so, obovoid or oblong, trigonous, biconvex, apex obtuse or acute, without apical button.

*Key to the species.*

A. Large middlesized herbs with stem 1-6 feet or more high.
  (1) Glumes with a subcordate base not inflated in front . *S. articulatus.*
B. Small tufted herbs with slender stems hardly reaching more than 1 feet high.
  (2) Glumes trapeziform, more or less as long as the blade . . . . . . . . . . *S. squarrosus.*

SCIRPUS ARTICULATUS Linn. (Pl. XXII, Fig. 4 & Pl. XXIV, Figs. 1-3.)

A perennial glabrous herb with the stems 1-3 feet tall, densely tufted, as thick as the little finger, light green with the white septa at intervals. Leaves present in juvenile forms before flowering, submerged, not appearing above water, long, tufted ribbon-like but decompose after the development of the inflorescence, bearing a sheath surrounding the culm. Sheaths with membranous acute tips about 1 inch long. Spikelets variable in length, ovoid or oblong, acute, terete or obscurely angular, rusty-brown, sessile in laterally stellately spreading clusters of 15-60. Bracts absent. Glumes as long as broad, broadly ovate acute, very shortly mucronate, closely imbricate, membranous, concave, persistent, scarcely keeled with a sub-cordate base and hyaline margins. Stamens 3, anthers linear, obtuse yellow. Style as long as the stigmas; stigmas 3. Nut obovoid, sharply triquetrous, black, opaque, shortly pointed, striate with transverse wavy lines.

*Hab.* A common amphibious plant throughout India from the sea-level to 3,000 feet. Flowering from January to May, fruiting September to December.

SCIRPUS SQUARROSUS Linn.

A slender glabrous tufted annual. Stem 3-6 inches long, filiform, striate. Leaves shorter than the stem, filiform acuminate, erect, smooth with involute margins. Sheaths short open. Spikelets solitary or 2-4 in a cluster, sessile, globose or oblong, obtuse green, many flowered, rachilla naked. Bracts 1-3, capillary, finely acuminate, leaflike, dilated at the base. Glumes closely imbricate, spreading and recurved, trapeziform with acutely angled sides, narrowed above into a recurved, cuspidate as long as or longer than the blade with a stout central nerve, very caducous in fruit. Bristles absent. Stamens 1-2, anthers, minute, oblong, apiculate, yellow. Style very short nearly absent, stigmas 3, minute recurved. Nut obovoid-ellipsoid, trigonous, yellow, brown or ultimately black.

*Hab.* Common throughout the Eastern peninsula extending from Assam to Ceylon reaching from the sea-level to 6,000 feet.

Family—GRAMINEAE.

Erect, decumbent or creeping herbs, sometimes floating or growing in water as tall weeds, rarely (Bamboos) shrubs or trees or climbers.

(canes), annual or perennial by means of rhizome Aerial stems simple or branched, generally terete or compressed with usually hollow or solid internodes Leaves distichous with a sheathing base distinct from the blade split down on one side, with usually an erect appendage (ligule) at the junction of the blade or petiole, thus the sheath ends in a ligule consisting of a more or less hyaline membrane or a fringe of hairs, blades, simple, usually long and narrow, lanceolate, linear, parallel-nerved, entire Inflorescence terminal sometimes terminal and lateral, composed of panicled, racemose, simply or compoundly spicate or capitate spikelets, rarely reduced to a single spikelet, rarely diœcious Flowers solitary or 2 many, aggregated in a spikelet Spikelets homogeneous or differing in sex and shape, unisexual or bisexual with all the florets bisexual or bisexual with only males, or females and males in the same spikelets Spikelets consisting of an axis (rachilla) and typically of 3 or more alternate, 2 ranked more or less heteromorphous bracts or glumes of which the two lowest form an involucral (involucral glumes) to the spikelets and are empty while the following flowering glumes (floral glumes) bear in their axils subsessile flowers subtended by a hyaline 2 keeled or 2 nerved dorsal scale (palea) Floral glume differing in structure and size from the involucral glumes and forming with the palea or flower proper false flowers or (florets) which are alike or different in structure and sex The florets are hermaphrodite or unisexual often with rudiments of the other sex, consisting generally of 2 minute hyaline scales within the palea representing the reduced perianth (sometimes absent) and of a stamens or pistils or both Stamens usually 3, rarely 6, 4, 2 or 1, very rarely more than 6 filaments slender often rather long, free rarely united anthers versatile with 2 parallel cells Ovary entire 1 celled, styles 2 rarely 3 or 1, free or connate at the base usually clothed above with simple or branched stigmatic hairs Fruit a seed like grain free within the flowering glume and palea or adnate to either or both Pericarp generally very thin rarely thicker and separable from the seed Seed erect Mature spikelets falling entire from the tips of their pedicels or together with the pedicels or breaking up above the glumes and separately

*Key to the genera*

A Spikelets 1 2 flowered not subtended by bristles branches of the panicle produced beyond the uppermost spikelets glume 1 minute orbicular hyaline — *Chamæraphis*

B Spikelets 1 2 flowered lower involucral glume (Gl I) distinct and empty glume II not fimbriate glume III with 2 nerved pale or quite empty — *Panicum*

C Spikelets 1 flowered —

(1) Glume I and II minute or setaceous III and IV chartaceous rarely awned — *Oryza*

(2) Glumes I and II absent III and IV membranous

(a) Glumes broad outer not awned — *Leersia*

(b) Glumes narrow outer awned — *Hygrorhiza*

(c) Spikelets forming a spicate monœceous inflorescence fruiting spikelets enclosed in the thorny polished nut like bract — *Coix*

(d) Spikelets paniculate with hairy rachilla and glabrous 3 nerved flowering glume — *Phragmites*

## Genus—CHAMAERAPHIS.

Glabrous marsh or aquatic grasses. Leaves narrow linear, lanceolate. Spikelets 1-2 flowered, subsessile or subsecund on the branches of a simple panicle which are produced as awnlike bristles beyond the ultimate spikelets, obscurely articulate but persistent on their short, obconic pedicels, narrowly lanceolate, terete, green. Glumes 4; I very small, suborbicular, hyaline, white, vein-less; II and III membranous, green, narrowly lanceolate; II acuminate 9-11 nerved longer than the III, the tip subulate or awned; III acuminate, 7 veined, paleate, male, the palea smaller than the glume, hyaline veins obscure; IV much smaller than the III stoutly stipitate, female, oblong or ovate oblong, acute, flat, thinly coriaceous, veinless, the palea as broad as the glume, veinless acute. Lodicules cuneate. Stamens 3, anthers very short; style free. Stigmas laterally exserted, hairs scattered. Grain minute oblong, compressed, free in the coriaceous glume and hyaline palea.

*Key to the species.*

(1) Stems stout, spikelets on branches of panicle few . . *C. spinescens.*
(2) Stems slender, spikelets on branches of panicle many . *C. gracilis.*

### CHAMAERAPHIS SPINESCENS Poir.

A floating herb with much branched masses of leafy stems 1-3 feet long. Leaves 1-3 inches by 1/16 to 1/8 inch broad, acuminate, narrowly linear lanceolate, smooth or scabrid, base narrowed. Sheath long, loose with naked margins; ligule a ridge of minute hairs. Panicle 2-4 inches long, shortly pedunculate, more or less contracted. Rachis angular, sulcate; branches filiform, angular, grooved, flexuous, few or many flowered, the lower 1-2 inches long, the awnlike tips ⅙ to ½ inch long. Spikelets subsessile. Glumes 4. Glumes I orbicular or subquadrate, usually rounded at the apex, hyaline; II lanceolate, setosely scabrid on the sides, membranous, 9-11 nerved, with a long scabrid awn which is sometimes as long as the body of the glume; Glume III finely acuminate or awned, 7 nerved male, paleate, membranous, palea hyaline smaller than the glume, linear oblong subacute; Glume IV ovate, lanceolate acute, female, nerveless, the palea hyaline.

*Hab.* Floating aquatic grass common in Lower Bengal and Peninsular India.

### CHAMAERAPHIS GRACILIS Hack.

A floating herb with decumbent stem rooting at the nodes, geniculately ascending having slender branches and internodes at a distance of 1-2 inches apart. Leaves—linear, acute, striate, base rounded, glabrous or sparsely hairy. Sheaths broad, loose, membranous compressed, 2-auricled, glabrous. Ligule short, hyaline, toothed. Panicle-shortly exserted beyond the upper sheath, 1-2 inches long, rachis and erecto-patent subsimple branches, capillary, smooth. Spikelets minute, very shortly pedicelled, green or brownish; blume I truncate; II straight, sometimes long acuminate, or almost beaked, glabrous or obscurely sparsely hairy, nerves close, strong; III shorter than II, subacute; IV absent-half of III.

*Hab.* A floating aquatic grass common in Lower Bengal extending down to South Burma.

Genus—PANICUM.

Annual or perennial grasses. Leaves broad or narrow, flat or rarely plicate. Ligule absent or usually reduced to a ciliate rim or fringe of hairs. Spikelets small and 2 flowered, terete or dorsally or laterally compressed, solitary or 2 nate, often secund, articulate on their pedicels and deciduous rarely awned. Glumes 4. Glume I and II empty; I smallest and fewest, veined; II and III usually subequal, oblong ovate or lanceolate; III usually neuter paleate or not; IV coriaceous or papery, sometimes shortly stipitate, convex 5-7 veined; paleate bisexual, the palea usually as long as the glumes, membranous; lodicules 2, cuneate. Stamens 3; style distinct, stigmas exserted near the top of the spikelet. Grain free, lightly embraced by the hardened glume and palea, oblong, ellipsoid or lanceolate.

*Key to the species.*

A. Rachis of spikes broad and flat, spikes longer than the internodes, spikelets glabrous, Glume IV smooth . . *P fluitans.*
B. Rachis of spikes narrow filiform, terete or angular; Glume I much shorter than Glume III, Glume IV obtuse, distinctly rugose . . . . . . . . . *P muticum.*
C. Inflorescence a spiciform panicle, glumes II and III 3-5 veined . . . . . . . . . . . *P Myurus.*
D. Inflorescence spiciform; Glume II and III, 7-9 veined; Glume I very minute . . . . . . . . *P. interruptum.*
E. Panicles broad, effuse:
(1) Leaves flat:
(a) Glume I nerveless, Glume IV smooth, ligule of fine erect hairs . . . . . . . *P. proliferum.*
(2) Leaves plicate:
(b) Glume I orbicular, 3 nerved, Glume II apiculate . *P. flavescens.*

PANICUM FLUITANS Retz.

Mostly perennial grass with prostrate stem floating below and rooting at the node, 1-4 feet long developing from a stout creeping base, smooth soft, striate, lower nodes 2-5 inches long, quite glabrous. Leaves 4-8 by ¼-⅜ inch linear, finely acuminate glabrous, the margins smooth a nearly so, often incurved base narrow. Sheath large, loose, rather dilated below, glabrous the margins not ciliate. Ligule a ridge of hairs. Panicle 8-12 inches long, rachis erect, angular, glabrous or nearly so. Spikes ½-1½ inch long, sessile longer than the internodes often appressed to the rachis, rachis of spikes flattened. Spikelets subsessile, turgid. Ovoid acute glabrous, 2 seriate, imbricate, Glumes 4. Glume I very short suborbicular, retuse, broader than long, thinly membranous, nerveless, white; II nearly equal to IV. Strongly 5-7 nerved tip rounded; III broadly ovate, acute, 5 nerved, paleate, empty or male; IV. Oblong subacute nearly smooth, broadly ovate, mucronate, thinly coriaceous, palea with inflexed membranous margins.

*Hab.* Perennial glabrous grass of marshes and ditches more or less occurring throughout India.

### PANICUM MUTICUM Forsk.

A rather stout grass with stems ascending 6-8 feet high, nodes softly bearded, rarely glabrescent. Leaves 6-10 inches long by ½ to ⅔ inch base subcordate; sheaths glabrous or hairy; ligule short, ciliate. Panicle deltoid, glabrous, erect, 3-5 inches long; rachis narrow, flattened, stiff, scabrid. Spikes alternate, rather distant, stout simple or divided below, lower 2-4 inches long, upper gradually shorter. Spikelets crowded, ovoid, acute, glabrous, turgid, sometimes solitary and alternate throughout the spike, green or purplish. Glumes 4. Glume I is equal to one fourth of Glume III, ovate acute, 1 nerved; II and III subequal 5 nerved, III paleate, male; IV ellipsoid, obtuse, margins narrowly incurved, obscurely dotted or roughened.

*Hab*. An introduced African grass cultivated or naturalised as far as 1845 in Bengal, Bombay and Ceylon commonly floating on surface of tanks, jheels, etc., and spread over marshy areas.

This aquatic grass is known as the water grass of Mauritius grass of Ceylon, a native of South America. This is considered as a valuable fodder grass.

### PANICUM MYURUS H. B. & K.

An aquatic grass with 2-6 feet tall erect, stout, spongy stem rooting at the nodes of the prostrate base. Leaves long 12-18 inches by ¾- inch flat, base cordate, tapering to a fine point, margin serrulate; sheat smooth, glabrous; ligule very short, rounded. Panicle narrow very cor pound, 6-12 inches often interrupted, sometimes quite cylindric. Spik lets erect, narrowly lanceolate, very shortly pedicelled, pale gre Glumes 4. Glume I—⅓ of Glume III, broadly ovate, acuminate; 3-nerved; III much longer than II, 3-5 nerved; IV small thin lanceol tapering into a long rigid erect beak, palea absent or imperfect.

*Hab*. Common in marshes of Bengal, Assam, Sylhet extendir Ceylon.

### PANICUM INTERRUPTUM Willd.

A grass of marshy places, with very stout 3-5 feet tall stem, below. Leaves long, flat 6-12 by ¼-½ inch base rounded hard tracted or subcordate, many nerved. Sheath smooth, ligule membranous. Panicle very narrow almost reduced to a spike strict, rachis stout, terete, short, membranous. Spikelets sp much longer than their pedicels, green, herbaceous. Spikelets very shortly pedicelled ovoid rather turgid, Glumes 4. Glum ⅓ of III, orbicular, hyaline, five nerved; II-III ovate-oblon strongly 9-nerved; III ovate oblong-obtuse; palea small; smaller, lanceolate acuminate, polished, white.

*Hab*. Common in swamps from the upper Gangetic plain extending to Burma.

### PANICUM PROLIFERUM Lam.

An aquatic perennial matted grass with erect stem fr base, 2-3 feet tall, lower nodes spongy. Leaves 6-12 b

linear or ensiform acute serrulate usually flat base broad and hardly cordate sheaths loose ligule a ridge of hairs Panicle 6 10 inches long often nearly as broad with long virgate spreading branches bearing short few flowered branchlets and solitary sessile or shortly pedicelled spikelets which lie parallel to the branchlets lower branches fascicled trigonous scaberulous Spikelets lanceolate green variable in size terete Glumes 4 Glume I—1/6 or 1/4 of Glume III orbicular II ovate acuminate or 9 nerved III lanceolate 9 nerved paleate or not IV oblong acuminate or smooth

*Hab* Common nearly throughout India growing in marshes or floating in stagnant water

### PANICUM FLAVESCENS Sw

An annual grass with erect 3 6 feet rather slender stem above stout branched prostrate creeping or rooting below Leaves plicate linear lanceolate 6 8 inches by 1/2 1 inch finely acuminate narrowed to the base thin flaccid softly hairy on the both surfaces sheath with hispidly ciliate margins towards the contracted mouth ligule somewhat obscure panicle 3 5 inches long erect spreading ovate oblong simple branches pubescent and bristly Spikelets subsecund subsessile green Glumes 4 Glume I—1/2 1/3 of Glume III orbicular obtuse 3 nerved II—1/2 of Glume IV apiculate 5 7 nerved III is equal to IV 5 7 nerved paleate male IV ellipsoid acuminate transversely rugulose

*Hab* An introduced grass common in Bengal extending to Assam and Burma in recent years first found its introduction in the Royal Botanic Garden Calcutta

It is generally a terestrial grass indigenous to Mauritius preferring to grow in shade and moist areas during and after the rains When growing along the sides of tanks and pools it tends to extend over the surface vegetation of a choked up tank and provide good shelter for the newly hatched mosquito larvæ

### Genus—ORYZA

Tall annual or perennial grasses Leaves long narrow flat spikelets 1 flowered loosely *arranged on the branches of an elongate or rarely* spiciform panicle disarticulating below the glumes laterally strongly compressed awned or not thickened at the base Glumes 1 3 I and II very minute subulate or obsolete III dimidiate oblong coriaceous or chartaceous hard keeled 5 nerved the lateral vein forming a thickened margin to the glume awnless or with a short or long straight terminal scabrid awn articulate in the glume palea linear as long as the glume 3 veined coriaceous with membranous margins lodicules 2 entire or 2 lobed stamens 6 anthers linear styles short free stigmas laterally compressed closely covered by or adnate to glume and palea

### ORYZA SATIVA Linn (Pl IV Fig 1)

An annual aquatic grass with creeping floating or erect stem 2 10 feet or more tall Leaves 1 2 feet by 1/4 1/2 inch or more flat somewhat striate 1 nerved scaberulous sheaths smooth ligule long 2 partite

Panicle at length drooping. Spikelets loosely panicled, not imbricating ½-½ inch long. Glumes I and II ¼-⅓ the length of III, lanceolate; hispid above, dorsally spinescently ciliate; with barbellate very long awn 3-5 inches in wild variety, awnless in cultivated varieties, yellow or reddish shining.

*Hab.* Common in all the districts nearly throughout India from the sea level to a height of 2-3,000 feet. In the hills it is cultivated in terrace.

The rice-plant is much cultivated in India and Burma for its edible grains which form the staple food in this country. The straw is used as fodder for cattle and also for thatching and other purposes. The grains of wild rice found in marshes of some parts of Bengal, Assam and Burma are eaten by poorer classes. The wild rice along with other aquatic species form by no means a less pest than water hyacinth in some of the larger expanses of shallow water logged localities. Eradication by mechanical means—by lifting them up with the root in the cold weather before fruiting period, and burning them before the advent of the rains is the best method to exterminate such aquatic pests. See, Photo V of Loktak Lake. The wild variety of rice is sometimes distinguished as Var. " Fatua ".

### Genus—LEERSIA.

Tall, perennial, aquatic grasses. Leaves narrow flat. Spikelets 1 flowered, in slender contracted panicles, articulate below the glume, strongly laterally compressed. Glume solitary, dimidiate, oblong thinly chartaceous, keeled, awnless the keel pectinately ciliate; lodicules 2, stamens 5. Styles 2, short, free, stigmas plumose, laterally exserted from the glume. Grain narrowly oblong, free within the glume and palea.

### LEERSIA HEXANDRA Sw. (Pl. III, Fig. 3.)

A floating perennial grass with stems rooting in the mud and floating flexuous branches several feet long, sending up erect or ascending slender leafy branches 2-4 feet high, smooth, striate, nodes hairy with deflexed hairs. Leaves 3-8 by ⅛-⅓ inch linear, tapering to a fine point, suberect rather rigid, nearly glabrous, with scaberulous margins, base narrow; sheaths nearly smooth, glabrous, the margins eciliate; ligule short, obliquely truncate or 2 lobed, membranous. Panicle filiform, branches filiform, flexuous, angular, smooth. Spikelets ⅙ inch long, dimidiate, oblong, smooth or scaberulous, pale green. keel of glume and palea rigidly ciliate, empty glumes absent. Flowering glumes thinner not awned. Ovate oblong, somewhat boatshaped, acute shortly mucronate. strongly keeled, ciliate on the keel and margins, 5 nerved the lateral nerves forming a thickened margin; palea as long as the glume, linear, lanceolate, subacute.

*Hab.* Common in marshes or as floating grass in stagnant water along with other vegetation, found nearly throughout India, Burma, extending from the lower Himalayas from Nepal eastward to Burma and down to the south Marhatta country and Madras and Ceylon.

## Genus—HYGRORHIZA

Floating glabrous grasses with stoutish diffusely branched stems rooting in dense masses at the nodes, branches short, erect, leafy Leaves short, broad, oblong, obtuse Spikelets few, erect, 1-flowered, jointed on the pedicels, but tardily dehiscent, lanceolate, long-awned, on the few wide spreading branches of a short peduncled panicle Glume solitary, thinly chartaceous narrowed to an erect scaberulous awn, strongly five veined, the veins scabrid, ciliate, lateral marginal, palea much narrower, 3 veined, acuminate, with ciliate keel, lodicules minute, suborbicular Stamens 6, anthers long very slender, style 2, free, stigmas feathery, laterally protruded Grain oblong, narrowed at the base, obtuse, free within the glume and palea

### HYGRORHIZA ARISTATA Nees

A glabrous floating grass, stem about 1 foot to 1½ feet or more long spongy with feathery whorled roots at the nodes Leaves 1-3 inches × ½-¾ inch linear or ovate oblong, obtuse, more or less scaberulous above, smooth and glaucous beneath subcoriaceous, with smooth or slightly scaberulous margins, base rounded or subcordate, midrib short, sheaths smooth, inflated, somewhat auricled, at the mouth compressed, with ciliate margins, ligule a narrow membrane Panicle about 2 inches to 3 inches long and broad, triangular, rachis and branches slender, stiff, smooth and linear branches sometimes deflexed Spikelets pale green pedicels articulate with a red annulus below the midrib, very narrow ¾ inch long including the awn, lanceolate with five strong nerved, the lateral nerves forming thickened margins hairy on the nerves outside, tapering into a long scarberulous awn as long as the body of the dorsally convex glume, palea as long as the glume

*Hab* Common in most of the provinces extending to Burma, spreading over the marshy areas or floating over the surface of tanks jheels, etc

## Genus—COIX

Annual or perennial tall, leafy, monœcious, erect or floating grasses with branching stem spongy within Leaves long, flat, wide Spike many, axillary fascicled and terminal, lower spikelets solitary, female, enclosed, in an ultimately hardened polished nut like bract, through the apex of which the pedicelled male portion of the spike protrudes Male spikelets 2 3 nate at each node of the rachis one sessile and 1 or 2 pedicelled, lanceolate Glumes 4 Glume I and II subequal, empty, rigid or herbaceous 1 keeled along the inflexed margins, III and IV hyaline, paleate, triandrous or empty lodicules 2, cuneate, fleshy. Female spikelets ovoid acuminate Glumes 4 Glume I chartaceous, II IV successively thinner IV paleate, staminodes 3, minute, lodicules absent Ovary ovoid styles 2 free slender, Grain orbicular, ventrally furrowed, enclosed in the hardened, globose, ovoid or cylindric, involucre

### COIX AQUATICA Roxb

A perennial aquatic grass with stems jointed, rounded, smooth, filled with pith ultimate shoots as well as those from the joints developing in

an oblique direction 4-5 feet above the surface of the water and bearing the leaves and flowers. Leaves linear, most acute with hispid margins, 1-3 feet long 1-1½ inch wide, the lower ones linear lanceolate, the superior ones ensiform. Spikes many flowered, terminal, peduncled, solitary or in pairs, drooping. Male flowers 3 fold, the 2 lateral ones sessile, the middle one pedicelled, all have 2 valved glumes with 2 valved flowers in each. Female flowers generally solitary on the base of the male spikes. Glumes turbinate, perforated from 6-7 valved. staminodes 3 rudimentary, style 2 fid. Grain turbinate, smooth of a dull pearl colour of the size of a pea.

*Hab*. Found floating in lower Bengal on lakes, jheels, etc., or creeping along the margins to a great extent from 50-100 feet.

This grass is supposed to be indigenous in Bengal. Some botanists are of opinion that this species may be reduced to a variety *Var. aquatica* of C. *Lachryma-Jobi*—commonly known as (Job's tears) occurring throughout in the wet parts of India and Burma and in some parts profusely cultivated for preparation of country liquor. In Assam it is cultivated during the rains in terrace along the hill-sides up to an elevation of 5-6,000 feet. (See photo.)

## Genus—PHRAGMITES.

Tall perennial grass with creeping rhizome. Stem stout, holl leafy upwards. Leaves long flat. Panicle usually very large and compound. Spikelets conspicuously silky from the long hairs on callus, loosely 3-10 flowered, awnless; rachilla disarticulating above lower and between the following floral glumes, slender, penicillate long hairs, not produced beyond the flowering glumes. Glume glabrous; glumes I and II unequal oblong lanceolate 3 nerved, membr persistent, III much longer, narrowly oblong lanceolate, acute 3 n male or neuter, persistent; flowering glumes subulate, lanceolat aristate, hyaline, palea much shorter than the glume, nearly ½ a linear-oblong, 2 keeled. Lodicules generally 2. Stamens comm Styles 2 distinct, rather short, stigmas laterally exserted, densely Grain oblong semiterete.

### PHRAGMITES Karka Trin.

A tall perennial grass with stems reaching 10 feet or above smooth, simple or somewhat branched, covered with the lea Leaves close, bifarious, linear, acuminate, reaching 1½ inch coriaceous, smooth, base contracted, margins smooth; sh glabrous, the mouth auricled; ligule a ciliate line. Pan long erect, oblong; branches widely spreading, filiform. S fully expanded about ½ inch broad across the glumes, pedi smooth; callus densely clothed with long silky hairs. Gl Glumes I and II oblong lanceolate, acute, 3 nerved. ( longer. Palea linear oblong.

*Hab*. Common throughout India in wet lands and pr along the river side and extensive areas and brackish

panses where they form a dense mass of pure association extending over a considerable area

A variegated variety of this is often cultivated in gardens for ornamental purposes The stems of the stouter ones of the wild species are used for thatching purposes This gregarious grass forming societies along the river banks, chars and shallow expanses of brackish water particularly the southern marshy and Sunderban areas of Bengal provides suitable abode for the mosquito larvæ of Anopheles and other disease carrying mosquitoes

## GRYPTOGAMIA.

### Pteridophyta (Ferns and Fern Allies).

### Filicales (Ferns).

### Eufilicineæ (True Ferns).

### Family—POLYPODIACEÆ

Herbs, rarely trees Caudex erect or creeping Fronds herbaceous or coriaceous rarely membranous, vernation circinate Sori dorsal or marginal with many sporangia with or without a covering indusium usually pedicelled, more or less completely surrounded by a jointed vertical, elastic ring and generally bursting transversely

*Key to the genera*

| | |
|---|---|
| Sori furnished with an indusium opening inwardly towards the midrib or frond veins supporting sori—2 3 longitudinal nearly parallel both to midrib and margin of the fertile frond | *Ceratopteris* |
| Sori without indusium not confined to the veins but spread over the whole undersurface of the fertile frond | *Acrostichum* |

### Genus—CERATOPTERIS

A somewhat succulent annual or perennial tufted herb Fronds dimorphic decompound, the barren pinnæ broad, lobed, the fertile linear veins anastomosing Sori situated on two or three veins running longitudinally down the fertile pinnæ nearly parallel with both midrib and edge Sporangia scattered on the receptacles sessile, subglobose, with a ring variously complete, partial or obsolete, indusium consisting of the reflexed margins of the frond, those of the two sides meeting against the midrib

### CERATOPTERIS THALICTROIDES (L.) Brong.

An aquatic fern with tufted, thick, inflated stipes filled with air spaces which aid in keeping the plant afloat on the surface of water Frond succulent in texture, the barren ones simple or slightly divided [illegible] somewhat erect when young 2-3 pinnate with rather narrow [illegible] ments when fully developed, fertile fronds 2-3 pinnate, [illegible] forked somewhat pod like

*Hab.* Common throughout India and Burma usually floating in masses on the surface of water in tanks, jheels, etc., or in rice-field sometimes stranded in mud or wet soil.

This species forms one of the important constituents of floating vegetation generally in fresh water expanses and aids in providing food and shelter to the mosquito larvæ. It propagates not only by its spores which when burst out spread over in tanks and when stranded in mud develop under suitable conditions into new plants. Vegetative reproduction takes place by means of buds borne on frond. Due to the stag-horn like character of the forked fronds the plant owes its generic name. The plant is generally annual but on moist areas or wet soil it perennates.

### Genus—ACROSTICHUM.

Herbs or low shrubs with tufted stipes adhered to the caudex or a creeping rhizome. Fronds variously simple or pinnate, unusually dimorphic, veins uniform, free or copiously anastomosing sori spread in a layer over the whole surface of the frond or its upper pinnæ, occasionally over both surfaces and not confined to the veins only; indusium absent.

### ACROSTICHUM AUREUM L. (Pl. XXIX, Fig. 2.)

A rather erect fern of brackish water marshes; Caudex erect; stipe 1-2 feet or more long, tufted, erect, glossy. Fronds 2-6 feet long 1-2 feet broad; pinnate, the pinnæ more or less lanceolate, the upper pinnæ fertile and slightly smaller than the barren ones which are usually stalked, ligulate, oblong, ½ to 3 inches broad, the apex acute or blunt, sometimes retuse, mucronate, the margin quite entire, base subcuneate, texture coriaceous, rachis and surfaces glabrous, areoles very small copious without free veinlets.

*Hab.* Abundant sometimes gregarious forming a pure society of its own in tidal areas throughout India and Burma, mostly preferring to grow along the salt water creeks and marshy brackish water areas or wet saline soils. Thus growing they are favourable abode of newly hatched mosquito larvæ of the salt and brackish water lakes, pools, canals and creeks, etc.

## Hydropteridineae (Water Ferns).

### Family—SALVINIACEÆ.

Annual or perennial aquatic herbs. Stems simple branched, giving off sessile or short petioled leaves on the upper side and copious root fibres downwards. The sporangia are grouped into sori; the sorus is enclosed in a highly developed indusium forming a sporocarp. Each contains only one kind of sporangia. Microsporangia containing numerous microspores. On germination microspore produces a rudimentary male prothallus. Macrosporangia containing a single macrospore from which a rudimentary female prothalus is produced.

*Key to the genera.*

| | |
|---|---|
| Root absent leaves of two kinds—one floating large entire and the other fil form root like submerged, sporocarps in clusters at the base of the submerged leaves | *Salvinia* |
| Root present leaves of one kind very small all alike, sporocarps in pairs on the ventral lobes of the first leaf of the branches | *Azolla* |

### Genus—SALVINIA

Free floating aquatic herb, annual or perennial with slender floating stem giving off shortly petioled or sessile fronds on the upper side and long filiform fibrous feathered root-like leaves downwards Fronds much larger than those of Azolla, entire, with a distinct midrib, that runs from the base to the apex and close erectopatent secondary veinlets connected by a few arches Sporocarps globose, indehiscent, monoecious, seated in clusters on the stem at the base of filiform submerged leaves The microspores germinate inside the sporangium, the prothallus protruding out of the wall as fine tubes at the end of which develop antheridia The macrospore forms a female prothallus which remain covered by the burst spore The prothallus has two parts one small celled green part bearing archegonia and the other one more large celled colourless part which stores reserved food for the embryo developing from the fertilised female cell (ovum) in the archegonium

*Key to the species*

| | |
|---|---|
| 1 Fronds horizontal flat | *S natans* |
| 2 Fronds suberect concave with infolded edges | *S cucullata* |

### SALVINIA NATANS Hoffm (Pl XXIX, Fig 3-A)

An annual or sometimes perennial aquatic free floating herb Fronds oblong, horizontal, more or less opposite at the joints, rounded or slightly cordate at the base ½-⅜ inch long ¼-½ inch broad bright green on the upper surface with about 18-20 erectopatent veinlets on each side of the midrib, each covered with tufts of minute bristles, the underside thinly matted like the stem with shining brown pellucid hairs Sporocarps 4 8 in a cluster, the cells of their walls regularly hexagonal

*Hab* Floating in lakes, tanks, jheels etc, throughout India and Burma mixed with other surface vegetation from the plains to a height of about 2,000 feet and very common in East Bengal, Assam extending to Burma

### SALVINIA CUCULLATA Roxb (Pl XXIX, Fig 3 B)

Branched annual or perennial free floating herb Fronds more or less opposite subsessile cowl shaped and tightly packed on the slender stem concave with inflexed margin on the upperside, ¼ to ⅝ inch in diameter, oval broadly cuneate or cordate at the base, veinlets 10 12 on each side of the midrib with 5 6 hexagonal cells in a row between them, papillæ of upper surface very minute and close, undersurface nearly naked Sporocarps at the base of the filiform rootlike fibrous leaves,

round ⅛ inch or slightly more in diameter, compressed at both ends, with the walls more or less marked by longitudinal ridges and furrows.

*Hab.* Free floating gregarious common water-plant forming sometimes pure association covering the surface of tanks, jheels, etc., found in the warmer parts throughout India and Burma.

Another Brazilian species Salvinia auriculata Aubet, has been received from Dr. E. Hanning of Munster, Germany, by exchange and introduced in the Royal Botanic Garden in February, 1933. This species is characterised by its orbicular fronds firmer in texture and larger than S. natans, deeply cordate base with the upper surface covered over with crested papillæ which towards the centre of the leaves are long thened out into prolonged pallucid subulate processes of empty cells, the undersurface is only thinly pubescent. Sporocaps 4-8 in clusters, the walls of the cells very flexuose. Abundantly fruiting in cold weather. This species although was received in a dried condition soon developed to its normal form and formed a colony within the course of a couple of months in the culture jar by its vegetative reproduction by means of offsets. In course of time if this species happens to find its access in ponds outside, will add to the list of another free floating pest of Bengal, but of course not such a formidable one as water hyacinth.

## Genus—Azolla.

Annual or perennial free floating aquatic herbs with branched sl stems with 2 leaves developing from each node. The leaves s densely imbricating, all alike, bilobed with a small cavity at the and each lobe with a single midrib, the cavity opening by a sma and inhabited by the alga *Anabaena azollae*. The root hang down in the water with root-cap but usually the root-cap falls a time. The sporocarps are formed in pairs on the ventral lob first leaf of the branches. Each sporocarp contains one Sor microspores are in several masses in each sporangium joined to the hardened frothy mucilage. Each of these massulæ are with barbed hairs on its outer surface. The megasporangium porangium contains one spore which sinks down and with ger the spore at the bottom floats on the surface with the fema and finally may be attached to the hairs of the massula microspore and thus the ovum in the archigonium of the p fertilised.

### Azolla pinnata R. Br. (Pl. XXIX, Fig. 4-A

A free floating annual or perennial, branched water-pla cled feathered filamentous roots. Frond oblong or deltoic long, with many crowded branches. Leaves sessile, mo nate, bifarious, imbricated, trapeziform, somewhat flesh the underside of the plant between the roots, cover scales. Leaf lobes firm in texture rather brittle, broad reddish brown especially during fructification, Macrosp numerous float corpuscles, its outer covering finely gra clavate papillæ. Massulæ of microspores provided slender processes one side.

*Hab* Throughout India ascending to about 3,000 feet in Assam and Burma occurring in fresh water lakes, pools, etc., free floating throughout the year forming one important smaller member of floating vegetation providing food and shelter to the mosquito larvæ

## Family—MARSILEACEÆ

Aquatic or subaquatic, herbs with widely spreading rather slender creeping or floating rhizomes Leaves circinate, single or in tufts from the nodes with floating or emergent blades Sporocarp equivalent of a leaf segment, not homologous to those of Salviniaceae, enclosing several sori consisting both of micro and macrosporangia Each spore with a epispore of hardened frothy mucilage The spores pass a dormant life inside the sporangia Microsporangia containing many microspores Megasporangia containing a single Macrospore from which a rudimentary prothallus is produced This family bears closer resemblance to terrestrial leptosporangiate ferns than that of Salviniaceae

### Genus—MARSILEA

Aquatic floating or amphibious herbs with creeping or floating rhizome bearing leaves at the nodes and roots on the lower side Leaves petiolate, with four leaflets sessile seated at the tips of 2-4 inches long slender petiole, spreading, deltoid cuneate or oblanceolate, floating or emergent, with flabellate anastomosing veins, exhibiting sleep movement by collapsing and folding upon one another at night and in cloudy days The sporocarp is a small bean like hard structure attached by a stalk to the leaves at the base of the petiole The sporocarp contains a number of sori each forming a chamber reaching from the ventral to the dorsal edge of the sporocarp In each sorus again on the outer side is a placenta in the form of a ridge bearing microsporangia on its sides and megosporangia on the top The latter as usual contains one spore each The sporocarp developing after the vegetative period mostly after the rains and maturing before the advent of the rains, many remain dormant for a long time But under favourable circumstances when mature the mucilaginous tissue inside swell up and ultimately bursts out of the hard coat With the absorption of sufficient water this tissue expand and develops into a long wormshaped structure to which are rather closely attached the sporangia The spores are finally set free by the dissolution of the indusium and sporangial wall and the prothallus develops in the usual way finally leading on to the fertilisation of the ovum

#### MARSILEA QUADRIFOLIATA Linn (Pl XV, Fig 4)

Rather large aquatic amphibious widely creeping or floating herbs Leaves with petiole 3 8 inches long, leaflets 4 glabrous, ½ to ¾ inch long outer edge rounded, entire or waved variously toothed or fringed, due to edaphic and climatic conditions Pedicels of sporocarp 2-4 nate ¼ to 1 inch long erect or connate with each other and somewhat adnate to the base of the petiole and upper part of the base of the sporocarps or free Sporocarp more or less bean shaped, round oblong ⅛ to ⅙

inch long, usually glabrescent when mature, not bordered, basal teeth minute sori many (16-20).

*Hab.* Common nearly throughout the warmer parts of India and Burma sometimes forming floating net work near the margin of tanks and ponds, etc., associated with *Ipomoea* and others.

This is used medicinally and profusely eaten as vegetable by the Indians. It appears that the distinction between *Marsilea minuta* Linn., which Baker notes occurs in the " plains of India " and *M. quadrifoliata* on the strength of the " leaflets conspicously toothed on the outer edge " is of transitory character. It has been found that *M. quadrifoliata* develop all these characters either during fructification, or when stranded on rather semidried soil or exposed to much sun light during dry season. Hence we agree with Dr. Sahni in his reducing *M. minuta* to *M. quadrifoliata*.

Prain's distinction of *M. quadrifoliata* having pedicels adnate to the base of the petioles and *M. minuta* having pedicels quite free from petioles has not been found to be a fixed character as they vary considerably according to the nature of the habitat of the plant growing in a locality. The description here has therefore been widened to include under *M. quadrifoliata* both the species.

## Isoetales.

### Family—ISOETACEÆ.

Aquatic or amphibious plant of the habit of a tufted grass w very short unbranched stem and enclosed by overlapping leaf l Leaves long linear like grass blades in the foliage portion, arran a close spiral and nearly every leaf towards the outside is a spo bearing a sporangium or traces of sporangium; at the base of the the adaxial side the ligule appears socketted in a small pit v sporangium below, forming a large deep chamber closed outside t film of tissue known as *velum*. The outer leaves bear micro and the inner the megasporangia which are traversed by strands or *trabeculae*.

As the leaves bear sporangium inside the socket at their plant itself or the sporophyte body is more or less a stro development of the solitary sporangium, presence of trabeculæ the anatomy of the stem and close resemblance of the game that of Selaginella suggest the relationship of this ord Lycopodiales. But the absence of suspensor, and developm gametophyte resembling gymnosperms the general habit of its highly specialised grass like leaves suggest " a living of the ancestors of monocotyledons ". This plant is p as " quillworts " due to the particular long linear characte

### Genus—ISOETES.

Aquatic or semiaquatic herbs with short stout rhizo less awlshaped leaves, spreading out at the base and

stem The roots branch out dichotomously from the stem below. Immediately above the base of the leaves on the innerside lies a large sporangium socketted in a small depression The outer leaves bear the microsporangium, the inner megasporangium and the innermost small, bear traces of sporangium or not sporangiferous at all The sporangium divided into imperfectly developed chambers due to the presence of strands of tissue running across front to back The main gametophyte consists of a single antheridum and the female gametophyte of a broad and short archegonium with the ovum which finally after fertilisation develops into a highly specialised embryo sporophyte

ISOETES COROMANDELIANA Linn (Pl XV, Fig 2)

An amphibious or semiaquatic plant of marshes or shallow water-logged areas with 3 lobed root-stock Leaves 6 15 inches long and about 1/12 inch in diameter at the middle portion, opaque, smooth *moderately firm in texture erect, filiform, semicolumnar, tapering to the* point furnished with copious stomata, the base somewhat membranous, dilated rather abruptly Sporangium large oval or oblong, pale, concave on the innerside, convex on the outerside, veil as or shorter than the sporangium. *Macrospores like grains of sand, chalk white with strong* ridges and prominent close tubercles

*Hab* Rather common in the marshes, moist soil of Southern India and in Bengal as reported by Griffith during the rains

## Bryophyta (Mosses and Liverworts).

### Family—RICCIACEÆ.

*Aquatic or terrestrial plants Thallus (gametophyte) flat, dichotomously branched with two dorsal and ventral surfaces The dorsal or the upper surface provided with air spaces without or with a rudimentary pores Antheridia and archegonia sparsely distributed on the dorsal surface, immersed in the tissue of the thallus Sporogonium embedded in the thallus without a stalk. Elators absent Spores are discharged with the disorganisation of the wall of the capsule and the decay of the thallus*

*Key to the genera*

A. Lower surface of the thallus without pores antheridia scattered in the thallus . . . . . *Riccia*
B. Lower surface of the thallus with distinct pores antheridia sunken in a median furrow of the thallus . . . *Ricciocarpus*

### Genus—RICCIA.

*Plants monoecious or dioecious mostly terrestrial forming rosettes in moist soil rarely floating in water with dichotomously branched thallus, the dorsal surface of which is marked by a distinct furrow Ventral scales generally in one row, but later on apparently two rowed Antheridia and archegonia irregularly mixed in numerous species Capsule immersed in the thallus Spore tetrahedral, the walls marked with ridges and armed with papillae frequently on the angles.*

### RICCIA FLUITANS Linn.

A free floating monœcious plant or stranded on mud, green or yellow green, thallus 1/2 to 4/5 inch long and about 1/16 inch broad, several times dichotomously branched, the segments divergent, linear. The floating from very thin, narrow, channelled towards the apex, without rhizoids or ventral scales green on both the surfaces. The terrestrial form broadly channelled tinged with violet along the margin. Rhizoids many. Ventral scales small confined to nearly the apex of the lobes, colourless or violet. Capsule forming a spherical protuberance on the ventral side of the thallus, furnished with rhizoids on the enclosing tissue. Spores 75-90 μ in diameter, brownish yellow, translucent, margin broad, entire or nearly so, outer surface with areola inner surface with irregular ridges. Antheridial ostioles prominent.

*Hab.* Floating freely on the surface of stagnant or slowly running stream, tanks, ponds and other water reservoirs or rooting in the mud when stranded at the sides or bottom common in the North Western India and also in Madras and Bengal.

The plant develops vegetatively from the adventitious branches formed from the ventral side of the thallus.

### Genus—RICCIOCARPUS.

Floating plants of dichotomously branched thallus of obcordate lobes and later fruiting on the muddy soil, rarely forming rosettes. Thallus provided mostly with polyhedral air chambers; the dorsal surface with distinct pores; ventral surface with long, dentate, violet coloured scales. Archegonium surrounded by a rudimentary involucre. Capsule immersed in the thallus. Antheridia situated in a toothed ridge in a medium furrow of the thallus.

### RICCIOCARPUS NATANS (L.) Corda.

Thallus 2/5 to 1/2 inch long and slightly less in width, 2-3 times dichotomously branched. Lobes obcordate with a distinct median furrow throughout, divided near the apex of the lobe. Air chambers large with unistratose walls, showing through the dorsal epidermis as hexagonal areole. Floating forms resemble Lemnas, green or somewhat violet with long pendant, serrated violet scales on the ventral surface with rhizoids few or absent. Terrestrial form in crowded imperfect rosettes, yellow green, frequently tinged with red, much reduced colourless or violet ventral scales and with many colourless smooth rhizoides.

*Hab.* Floating freely in stagnant water or rooting when stranded on mud at the bottom or along the margin, with Lemna, Salvinia natans and Azolla species and other floating vegetation in the Dal Lakes of Kashmir and Assam particularly abundant in the Loktk Lake, Manipur.

It is doubtful if the plant is definitely diœcious. Fertile specimens are very rare and the collection of Kashyap, Sahni and Biswas are all sterile. The plant mostly grow rather rapidly by means of its vegetative reproduction by splitting of the thallus along the median line, the halves thus separated developing into new plants.

## ALGÆ

Four groups of algæ are recognised The classification is mainly based on colouration The blue green algæ are known as Cyanophyceæ the green algæ Chlorophyceæ the brown algæ Phæophyceæ and the red algæ Rhodophyceæ

Phæophyceæ and Rhodophyceæ are nearly all marine and have not been considered to be within the scope of the present work The blue green and green algæ are further sub divided into various sections and families out of which only the most common algæ found to be typical aquatics having direct or indirect bearings on mosquito life have been incorporated

### Cyanophyceæ (Blue-green algæ)

### Family—CHROOCOCCACEÆ

Plant mass exhibiting no difference between basal and apical regions solitary or associated in gregarious families or colonies of indefinite shape reproduction in one two or three directions of space

The genera *Chroococcus* and *Mycrocystis* are the two common genera found in fresh water *Chroococcus turgidus* colonies 2 16 celled —cells angular by mutual pressure found in filter beds throughout the country *Microcystis* of which the cosmopolitan species *M aeruginosa* Kutz (Pl XXX Fig 1) colonies annual or perennial clathrate of irregular shape composed of numerous spherical densely aggregated cells of blue green colour 3 4 μ in diameter This is the most common plankton species found floating in nearly all kinds of inland water reservoir throughout the plains of India and Burma

The alga lends a characteristic blue geen colour to an expanse of water Under closer examination it presents a finely blue green granular appearance to the naked eye During hot weather when the alga reaches its climax the floating masses of this alga deteriorate due to exigencies of the weather and its putrefaction sets up unhealthy rotten vegetable odour in and about the tank jheel etc Another species *M flosaquc* Kutz with its colonies oblong with an indistinctly defined hyaline mucous investment are also a common constituent of plankton The condition set up by these plankton algæ offer favourable medium for breeding of mosquito larvæ to grow

### Family—OSCILLATORIACEÆ

Plantmass forming expanding slimy layer on substratum filaments unbranched with sheaths of variable thickness trichomes of uniform row of discoid cells straight or flexuous or sometimes twisted or spirally coiled heterocyst absent reproduction by cell division or homogone Filaments in *Oscillatoria* often exhibiting oscillating movement

Four aquatic genera are distinguished by hardly any sheath and cylindrical trichomes—*Oscillatoria* spirally coiled trichomes—*Spirulina*

filaments agglutinated by mucous sheath—*Phormidium;* filaments with thick persistent sheath sometimes lamellose—*Lyngbya.*

### Genus—OSCILLATORIA. (Pl. XXX, Figs. 2—5.)

A large number of species of *Oscillatoria* are found in wet and aquatic medium throughout India and Burma. The following are the most common species :—

*Oscillatoria princeps* Vauch.—filaments broad forming network of thick crowded green blue or black floating masses in fresh or brackish water; trichomes 16-60 μ in breadth, apex truncate or somewhat convex; cells 2-4 in length.

*Oscillatoria tenuis* Ag.—filaments floating single or as membranes with other algæ; cells 4-12 μ in breadth; 2-4 μ in length, partition walls marked by row of granules on either side, apex broadly rounded or slightly thickened.

*Oscillatoria amphibia* Ag.—filaments forming slimy membranous virdigris green or blue-gree expansions or mixed with other algæ; cells 2-6 μ broad, 7-10 μ long apex somewhat conical, cell-contents with refringent granules.

*Oscillatoria splendida* Grev.—filaments mixed with other algæ or forming floating membranes, cells 2-4 μ broad, 2-4 times longer; apex prolonged variously bent or curved ending sometimes with a knob, partition walls marked by row of granules on either side.

### Genus—SPIRULINA. (Pl. XXX, Fig. 6.)

The genus *Spirulina* are often found associated with plankton algæ and present in water which does not indicate high sanitary state of water.

*Spirulina maior* Kutz.—plantmass when aggregated together forming blue-green or when exposed to sun light yellowish green somewhat expanded membrane but commonly filaments found scattered among other algæ; trichomes 1-4 μ in diameter, somewhat flexuous, regularly spirally coiled, length of each turn 4 μ, distance between the turns 6 μ; contents granular blue-green.

*Hab.* Common throughout the plains of India in fresh or brackish water lakes, jheels, tanks, pools, etc.

### Genus—PHORMIDIUM.

*Phormidium tenue* (Menegh.) Gomont.—plantmass bluish green, forming thin membranous layers, filaments very narrow, densely entangled, sheaths very thin and delicate, somewhat inconspicuous, finally diffluent; trichomes 1-2 in diameter, straight or somewhat curved, apex more or less tapering, slightly constricted at the joints; cells distinctly separated by means of pellucid dissepiments, 2-5 long; apical cell somewhat conical or blunt; cell contents homogeneous, pale blue-green.

*Hab.* Common in the plains of throughout India, either forming stratum on flooded areas, or along the edges of tanks and mixed with other algæ in various other situations.

## Genus—Lyngbya. (Pl. XXX, Fig. 7.)

*Lyngbya ærugineo-coerulea* (Kuetzing) Gomont.—plantmass dull blue-green forming an expanded layer at first on the substratum but later on when lifted floating on the surface as thin blue-green membranous mucous fragments or mixed up with other algae as solitary filaments; filaments long, rather flexuous; sheaths thin, hyaline, firm sometimes 1 μ in thickness; trichomes 4-6 μ in diameter, not constricted at the joints, apex hardly tapering, apical cell rotund rarely with slightly thickened outer membrane; cells—quadrate or more often longer than broad, 3-8 μ in length, partition walls distinct, pellucid, rarely with granules along the partition walls, contents granular, blue-green; gonidia is not of rare occurrence in some of the forms.

*Hab.* Common everywhere in the warmer parts of India, commonly in fresh water, sometimes in brackish water.

*Lyngbya æstuarii* (Martens) Liebman.—plantmass widely expanded forming matted layers on the substratum, when lifted floating in large woolly masses, blackish or dull blue-green; filaments long, flexuous forming entangled masses, rather tenacious, densely crowded, 14-22 μ in width; sheath 1-2 μ in thickness at first hyaline, smooth, firm, thin, finally becoming thick, lamellose, with somewhat roughened surface; trichomes 8-14 μ not constricted at the joints: apex hardly tapering, rarely slightly capitate; apical cell, obtusely rounded, sometimes with slightly thickened outer membrane; cells 2-4 μ in length; cell-contents granular blue green.

*Hab.* Common in all the estuarine areas extending right up to the edge of the water or stranded on sandy, muddy or silted areas among the mangroves throughout the coastline of India.

## Family—NOSTOCACEÆ.

Plantmass at first globose or oblong but later on foliose or bullose blue-green or variously coloured consisting of a large number of unbranched filaments embedded in the mucous; sheaths distinct enclosing a large number of trichomes homogeneous in structure, persisting or diffluent, variously coloured; trichomes with terminal or intercalary heterocysts uniseriate or flexuous and centered with torulose or sometimes cylindrical cells; cells spherical, oval, hemispherical, or oblong cylindrical, straight or rigid; cell contents blue-green or variously coloured. Production by hormogones due to the fragmentation of the fully grown trichomes or by spherical, oval, ellipsoidal, cylindrical spores arising in relation to the heterocysts.

## Genus—Anabaena. (Pl. XXX, Fig. 8.)

*Anabæna sphaerica Bornet* et Flahault.—plantmass floating, blue-green; sheaths not distinct around the trichome, hyaline, soon dissolving in water; trichomes 3-6 μ in diameter, moniliform, straight, generally agglutinated together in more or less parallel bundles, or somewhat flexuous, cells depressed spherical, or spherical truncate or barrel-shaped 3-4 μ long, 3-6 μ broad, apical cells more or less conical, cell contents

granular, blue-green, heterocysts 4-8 in diameter, nearly spherical; resting spores 9-14 μ long and 6-10 μ broad, nearly spherical or elliptic, either solitary or contiguous to heterocysts, often in short chain like series, with thicker membrane, outer wall smooth, when old slightly brownish yellow.

*Hab.* Common throughout warmer parts of India in fresh water tanks, jheels and inundated areas.

*Anabæna flosaque* (Lyngbya) Brebisson.—plantmass frothy, gelatinous, lubricous, floating, blue-green; sheaths hyaline, soon disappearing into water liquid hence almost always absent in individual filament; trichomes 4-8 in diameter, more or less spirally twisted or circinate, often making 2-4 turns; cells 6-8 μ long, 4-8 μ broad, compressed spherical, or almost exactly globose; heterocysts a little wider and longer than the cells, or ellipsoidal, intercalary, never terminal, about 6-10 μ long and 4-9 μ broad; resting spores 20-50 μ long and 6-13 μ broad, slightly curved or oblique, inequilateral, contiguous to or sometimes remote from heterocysts, often enveloped by a gelatinous sheath, outer wall smooth, colourless or pale yellow; cell contents with or without pseudovacuole, granular, blue-green.

*Hab.* Common throughout warmer parts of the plains of India and Burma.

It is a free floating blue-green plankton alga sometimes mixed with *Microcustis æruginosa* forming what is generally known as "water bloom". The alga is in juvenile form during February to April and produces gonidia or resting spores during May to June before the advent of the rains when it often sinks down or is distributed to different reservoirs of water and thus reappears annually under suitable condition. During the period of fragmentation sometimes in association with other plankton algæ, chiefly *Microcystis æruginosa*, *Spirulina maior* and *Spirulina Platensis* the sanitary condition of the water of a tank containing densely crowded floating masses of algæ is changed to such unhealthy state due to development of putrefaction bacteria as it offers favourable media to the growth of larvæ and other similar animal organisms.

## Family—RIVULARIACEÆ.

### Genus—GLŒOTRICHIA. (Pl. XXX, Fig. 9.)

*Glœotrichia natans* (Hedw.) Rabenhorst.—plantmass at first attached to the substratum, spherical or globose but later on free floating as bullate, hollow, soft jelly like pale olive green or greyish green indefinite mucous masses of varying dimensions, sometimes more than 10 cm. in diameter; filaments loosely aggregated, sheaths enlarged forming wing like conspicuous expansions at the basal portion, trichomes 7-10 μ in diameter, tapering into long fine hair like apices, lower cells somewhat barrel-shaped, more or less as long as broad, upper cells longer than the diameter, sometimes four times as long as broad, cell-contents granular blue-green; heterocysts 6-12 μ in diameter, usually spherical; gonidia cylindrical erect or slightly curved, without the sheath 10-18 μ in diameter, 40-250 μ

in length, external sheaths up to 40 μ in thickness, sometimes folded or wrinkled or wavy at the margin, hyaline, pale brownish or yellowish

*Hab* Common throughout the hotter parts of India and Burma in fresh water as free floating mucous masses of colonies

Another smaller species—*Glœotrichia pisum* (Ag ) Thur is frequently found attached to submerged plants and other substrata as small gelatinous globose bodies of about 2 mm in diameter or as large as a grain of pea *Glœotrichia echinulata* (J E Smith) P Richter, has been recorded from Burma

## Chlorophyceae (Green Algae).

### Family—VOLVOCACEÆ

Plants forming autocolonies enveloped in a hyaline, homogeneous gelatinous sheath *cœnobia of definite shape with definite or indefinite* number of mobile cells often arranged in a globose layer one cell in thickness, cells all similar, or differentiated into vegetative and reproductive cells, vegetative cells spherical, ellipsoid, pyriform or disciform with or without connecting cytoplasmic strands nearly always biflagellate often with two contractile vacuoles one eyespot and a cup shaped chloro plast with one or more pyrenoids asexual reproduction by repeated division of on or some of the cells in the colony resulting in autocolonies sexual reproduction by division of all cells in the colony developing iogamous zoogamates or heterogamous zoogamates of slightly different size or by a true oogamy by the formation of spheres and oospheres resulting in oospores zygote with a thick outer wall smooth or ornamented germination by the discharge of protoplaests which by dividing and redividing forming daughter colonies

### Genus—GONIUM (Pl XXX Fig 10 )

*Gonium pectorale* Muel —colonies more or less square plate with rounded corners 4 16 celled the 16 celled colonies with 4 central and 12 peripheral cells 50 μ in diameter cells globose 10 12 μ in diameter

*Hab* In small fresh water pools and puddles or temporary stagnant water reservoirs often mixed with other algæ

### Genus—PANDORINA (Pl XXX Fig 11 )

*Pandorina morum* (Mull) Bory —colonies spherical or oblong elliptical 20 40 μ in diameter or when old 50 60 μ long 40 50 μ broad, composed of 4 8 16 or 32 cells cells 6 10 μ long and 15 20 μ broad pyriform or angular by mutual pressure epispores of zygote thick walled smooth orange red

*Hab* Common in fresh or brackish water pools or rain water temporary puddles throughout the warmer parts of India and Burma

This is one of the common plankton often associated with *Euglena* species lending the surface water a green colour The presence of this algæ forming " water bloom " indicates fairly high organic contents of

the water which are suitable for sustaining mosquito life. Various shapes and sizes of the alga has been observed in different habitats both spherical as well as elliptic-oval. The authors, therefore, are not in favour of separating the Indian forms as oblonga as suggested by Iyengar in his paper entitled "Contributions to our knowledge of the colonial volvocales of South India", Journal of the Linnean Society, Vol. XLIX (No. 329), pp. 328-329, 1933. Iyengar's new form of this species—*P. morum*, forma major Iyengar, may also be conveniently reduced to the forma typica, as production of more than one pyrenoids, larger size and other differences depend on age, climatic conditions, and nature of food materials of the medium in which the alga passes through its life history.

### Genus—VOLVOX. (Pl. XXX, Fig. 14.)

*Volvox aurens* Ehrenberg.—colonies spherical or subglobose, 250-600 μ in diameter, with 500-1,000 cells, cells round 5-8 μ in diameter, with several daughter colonies is asexual cœnolia, sexual colonies with a few oogonia; oospore when mature 30-50 μ in diameter with or without the spines, spines about 5 μ in length, all over the epispore of the zygote.

*Hab.* Common throughout hotter parts of India and Burma, in fresh water pools and puddles often colouring the water green which when examined closely appear granular to the naked eye. The alga is "oligosaprob" often found in pure association forming the so-called water bloom preferring fresher water, abundant in Calcutta filterbeds. Several species have been recorded recently by Iyengar.

## Family—HIDRODICTYACEÆ.

### Genus—PEDIASTRUM. (Pl. XXX, Figs. 12—15 & Pl. XXX, Fig. 6.)

*Pediastrum simplex* (Meyen).—colony simple discoid stratum consisting of a central polygonal cell (which may sometimes be absent) and 4-16 or more peripheral pentagonal cells having one inner and two lateral straight or nearly straight sides, contiguous with corresponding sides running into an acute cusp somewhat longer or shorter than radical dimensions of the remaining part of the cell; length of peripheral cells including about 20 μ, greatest width about 10 μ diameter of the central cell 13 μ chloroplasts filling the cell minus the dark or pale green, finely granulose; pyrenoid conspicuous, central colourless.

*Pediastrum duplex* Meyen.—colony generally of 8-32 cells; central cell rounded at the corners, marginal cells thickened towards the base, bilobed at the apices, lobes broad or narrow tapering at the apices, apices straight, erect, convergent or divergent with acute knob like or bidentate ends.

This is a very variable species and there are about 15 species of which the following variety is common in India and Burma :—

Var. (a) *genuinum* Al Broun 65 μ in diameter (32 celled) marginal cells ovote, 12 μ long and 9 μ broad, central cell subquadrate, 12 μ long and 9 μ wide, sides concave, gaps subcircular about 6 μ in diameter.

*Pediastrum Tetras* (Ehrenberg) Ralfs —colony commonly 4-16 celled, suborbicular, 50 μ in diameter, marginal cells subpentagonal, 12 μ long and 8-9 μ broad, deeply bifid, subparallel incision about 2-4 μ in diameter, intermediate cells 8 9 in width, central cell irregularly pentagonal, cell-wall smooth, contents granular, pyrenoids single, cells often with scattered vacuoles in older stages

*Hab* Common (nearly cosmopolitan) throughout India and Burma extending to Malaya in old lakes, stagnant pools, puddles and filterbeds

### Genus—HYDRODICTYON (Pl XXXI, Fig 5)

*Hydrodictyon reticulatum* (L) Lagerheim —free swimming nets, up to 15-20 cm rarely 30 cm long, cœnocytes long cylindrical, when mature generally 3-5 mm long reaching up to 1-1 5 cm. in length, quiescent zoospores 13 25 μ long, swarming zoospores 10 μ long 8 μ wide, gametes a little smaller

*Hab* Common in large quantity all over India and Burma in stagnant fresh water tanks, pools and open filterbeds floating in masses The alga is popularly known as the " water net "

Another larger species *Hydrodictyon reticulatum* Iyengar with brittle cœnocytes has been discovered in Madras This species is rather rare

## Family—CHLORELLACEÆ

### Genus—CHLORELLA (Pl XXX, Fig 13)

*Chlorella vulgaris* Beycrinck —cells spherical tending to aggregate into colony, yellowish green, 4 8 in diameter, often with one pyrenoid, more or less situated in the middle, cell wall smooth, thin hyaline, cell-contents rather coarsely granular, green

*Hab* Abundant throughout India and Burma forming often thin green or yellowish green surface film in stagnant pools and reservoirs of wate. The alga is adapted to the most variable conditions of life It can be grown in stoppered bottle indoors It admits of pure culture and can easily be grown in normal saline and other culture solutions and also in solid media particularly Agar Agar When grown in pure solution the cells assume smaller size varying from 2 6 μ diameter unlike *Protococcus viridis* which evidently due to its more subaerial nature assume larger and healthier forms. This alga although generally free living yet capable of growing within the cells or tissues of invertibrates and thus establishing a symbiotic relationship with the animals Another species *Chlorella pyrenoidosa* Chick—has been observed to grow indoors in water rich with organic matters Members of the allied family of Oocystaceæ, of which the *Oocystis roteundata Schmidle*, *O solitoria* Wittrock, *O lacustris* and *O elliptica* W West are not infrequently associated with *Chlorella*, as also *Ecdysichmalys obliqua* G S West, *Tetraidron minimum* (Al Broun) Honsgird *T caudatum* (Corda) Honsgirg var *longispinum* Lemmerman, *T pentaedricum* W & G S West, *T bengalicum* Wille These delicate unicellular algæ occurring in water of question able sanitary condition offer fairly suitable food material for the mosquito larvæ

the water which are suitable for sustaining mosquito life. Various shapes and sizes of the alga has been observed in different habitats both spherical as well as elliptic-oval. The authors, therefore, are not in favour of separating the Indian forms as oblonga as suggested by Iyengar in his paper entitled " Contributions to our knowledge of the colonial volvocales of South India ", Journal of the Linnean Society, Vol. XLIX (No. 329), pp. 328-329, 1933. Iyengar's new form of this species—*P. morum*, forma major Iyengar, may also be conveniently reduced to the forma typica, as production of more than one pyrenoids, larger size and other differences depend on age, climatic conditions, and nature of food materials of the medium in which the alga passes through its life history.

## Genus—Volvox. (Pl. XXX, Fig. 14.)

*Volvox aurens* Ehrenberg.—colonies spherical or subglobose, 250-600 μ in diameter, with 500-1,000 cells, cells round 5-8 μ in diameter, with several daughter colonies is asexual cœnolia, sexual colonies with a few oogonia; oospore when mature 30-50 μ in diameter with or without the spines, spines about 5 μ in length, all over the epispore of the zygote.

*Hab.* Common throughout hotter parts of India and Burma, in fresh water pools and puddles often colouring the water green which when examined closely appear granular to the naked eye. The alga is " oligosaprob " often found in pure association forming the so-called water bloom preferring fresher water, abundant in Calcutta filterbeds. Several species have been recorded recently by Iyengar.

## Family—HIDRODICTYACEÆ.

## Genus—Pediastrum. (Pl. XXX, Figs. 12—15 & Pl. XXX, Fig. 6.)

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This is a very variable species and there are about 15 species of which the following variety is common in India and Burma :—

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*Pedıastrum T* ' • (ꜰ' ' ' R " ' nly 4-16 celled, suborbicular, 50 ;onal, 12 μ long and 8-9 μ broad, 4 μ in diameter, intermediate cells 8 9 in width, central cell irregularly pentagonal, cell-wall smooth, contents granular, pyrenoids single, cells often with scattered vacuoles in older stages

*Hab* Common (nearly cosmopolitan) throughout India and Burma extending to Malaya in old lakes, stagnant pools, puddles and filterbeds

Genus—Hydrodictyon (Pl XXXI, Fig 5)

*Hydrodictyon reticulatum* (L) Lagerheim —free swimming nets, up to 15-20 cm rarely 30 cm long, cœnocytes long cylindrical when mature generally 3-5 mm long reaching up to 1-1 5 cm in length, quiescent zoospores 13 25 μ long swarming zoospores 10 μ long 8 μ wide, gametes a little smaller

*Hab* Common in large quantity all over India and Burma in stagnant fresh water tanks, pools and open filterbeds floating in masses The alga is popularly known as the " water net "

Another larger species *Hydrodictyon reticulatum* Iyengar with brittle cœnocytes has been discovered in Madras This species is rather rare

## Family—CHLORELLACEÆ

Genus—Chlorella (Pl XXX, Fig 13)

*Chlorella vulgaris* Beyerinck —cells spherical tending to aggregate into colony, yellowish green, 4 8 in diameter often with one pyrenoid, more or less situated in the middle, cell wall smooth thin hyaline, cell contents rather coarsely granular, green

*Hab* Abundant throughout India and Burma forming often thin green or yellowish green surface film in stagnant pools and reservoirs of water The alga is adapted to the most variable conditions of life It can be grown in stoppered bottle indoors It admits of pure culture and can easily be grown in normal saline and other culture solutions and also in solid media particularly Agar Agar When grown in pure solution the cells assume smaller size varying from 2 6 μ diameter unlike *Protococcus viridis* which evidently due to its more subaerial nature assume larger and healthier forms. This alga although generally free living yet capable of growing within the cells or tissues of invertibrates and thus establishing a symbiotic relationship with the animals Another species *Chlorella pyrenoidosa* Chick—has been observed to grow indoors in water rich with organic matters Members of the allied family of Oocystaceæ, of which the *Oocystis roteundata Schmidle*, *O solitoria* Wittrock, *O lacustris* and *O elliptica* W West are not infrequently associated with *Chlorella*, as also *Ecdysichmalys obliqua* G S West, *Tetraedron* [illegible] *mum* (Al Broun) Honsgird *T caudatum* (Corda) Honsgirg, var [illegible] *pinum* Lemmerman *T pentaedricum* W & G S West, *T.* [illegible] Wille These delicate unicellular algæ occurring in water of [illegible] able sanitary condition offer fairly suitable food material for the [illegible] larvæ

## Family—SCENEDESMACEÆ.

### Genus—SCENEDESMUS. (Pl. XXX, Fig. 16 & Pl. XXXI, Fig. 1.)

*Scenedesmus acuminatus* (Lagherheim) Chodat.—colony of four to eight cells in single or double series; cells narrowly fusiform somewhat sickleshaped and cells strongly sickleshaped or lunate tapering into sharp acuminate teeth, 14-24 μ in length without and 2-4 μ in width.

*Hab.* Common in standing water and filterbeds throughout India and Burma. The Indian forms are smaller in dimensions.

*Scenedesmus quadricauda* (Turpin) Brebisson.—colony of 2-16 cells in single or double series; cells oblong-cylindrical, obtusely rounded at both ends, closely attached to one another along the lateral walls, the outer cells armed with curved spines; 8-125 μ long, 2-6 μ wide, spines 8-15 μ long.

*Hab.* Very common in all stagnant waters and filterbeds throughout India and Burma. There are several varieties of this species according to the nature of the distribution of spines in the cells.

*Scenedesmus perforatus* Lemmerman.—colony of 2-8 cells, cells 16 μ long, 4-6 μ wide, middle cells oblong more or less concave on either side, obtusely rounded at their apices, marginal cells convex on the outer sides and furnished with divergent spines at both ends; spines 10-12μ long; gaps intercellular, three in number in a 4 celled colony, 8 μ long and 2 μ wide.

*Hab.* Common in stagnant lakes, jheels and ponds throughout India and Burma.

## Family—TRIBONEMATACEÆ.

### Genus—TRIBONEMA. (Pl. XXX, Fig. 2.)

*Tribonema bombycinum* (Ag.) Derbes and Sol.—filaments floating freely in densely entangled mass nearly throughout the season in fresh water, light green or when somewhat exposed yellowish green, cells 3-5 times longer than broad, 30-100 μ long and 15-22 μ wide; akinetes and aplanospores and abnormal cells are developed when starved or exposed directly to the hot sun.

*Hab.* Common throughout the plains of India and Burma in fresh water lakes, tanks, pools, in shallow springs, etc. The alga seems to prefer better condition of aëration. When floating in masses it offers shelter and food to mosquito population.

## Family—CLADOPHORACEÆ.

Plant body richly branched filaments except in the genera *Chæto-morpha* and *Rhizoclonium*, composed of elongated or cylindrical multinu-cleated cells; chloroplasts or chloroplasts occupying the external zone of cytoplasm mostly with a large number of pyrenoids surrounded by a conspicuous sheath of starch plates; cell-wall hardly secreting mucilage hence rough and crisp to the feel serving suitable substratum for many

species of Diatoms blue green or green algæ, vegetative reproduction by means of transverse division of the apical cells or by intercalary division, asexual reproduction by means of akinetes or quadriciliated zoospores, sexual reproduction by means of isogamous biciliate gametes, the zygospore germinating without a period of rest Alternation of generation can be traced from the haploid and diploid thalli and some species (*Chætomorpha* and *Cladophora*) exhibiting heterothallism

The members of this family are widely distributed aquatic plants and sometimes found floating in large masses as in *Cladophora, Pithophora* and *Chætormorpha* or forming dense cushions or carpet on wet substratum exposed to tidal or other overflow water as in *Rhizochonium* and *Cladophora*

Genus—CLADOPHORA (Pl XXI Fig 3 & 4)

*Cladophora glomerata* (L) Kuetzing —plantmass fasciculate, penicellate, attached to the substratum by branched rhizoids (heptron or holdfast) never floating except when dislodged from the substratum, branches dense, in tufts and pseudodichotomous, cells varying widely in dimensions according to age and position of the cells in first, second or third or more order of branches, older cells 250-300 µ in length and 75-80 µ in width, cells of comparatively middle age 100 200 µ long and 25-40 µ broad apical cells 130 350 µ long and 20 25 µ in width, intermediate or apical cells fructiferous aplanospores spherical or oval about 10 µ in diameter

*Hab* Common throughout India and Burma in fresh water hill streams or flowing water or in tanks and lakes, attached rocks and bricks and other hard substrata Pustules of C *glomerata* often develop on old shells of snails or other larger crustacea and are carried along with them as they swim about Floating balls of *Cladophora* when dislodged from the substrata are frequently met with The species is adapted to varying conditions of water and has been found to grow in great abundance in brackish water areas and salt water lakes such as the Chilka Lake

The allied species *Cladophora crispata* (Roth) Kuetzing particularly the variety *genuina* (Kuet) Rabenhorst of fresh water reservoirs are also found to *grow profusely in streams, flowing water tanks and filterbeds* The growth of this algæ is very rapid and their quick development in huge masses prove to be of great drawback in open filterbeds The entangled plants like many other algæ of the same habit provide accommodation to mosquito larvæ as well This species is distinguished from C *glomerata* by its long little ramified ultimate branches and rarity of apparent dichotomy and thinner cell walls, and narrower cells diameter of the older cells varying from 40-70

Genus—PITHOPHORA (Pl XXXII, Fig 1)

*Pithophora œdogonia* (Mont) Willr —plantmass of entangled filaments forming cushions at first attached to the substratum but later on free floating, branches of 1-3 orders cells of the primary branches broader about 900 µ long and 70 130 µ wide terminal vegetative cells as long as 370 µ long and 70 µ broad, akinetes intercalary or terminal, slightly inflated at the middle, sometimes somewhat barrel shaped, the terminal akinetes much

shorter than the vegetative cells, sometimes somewhat conical with obtusely rounded apices, intercalary akinetes often in pairs, about 100 to 180 μ wide, 40-250 μ long, black or blackish brown when mature. *P. œdogonia*, var. *vaucheriodes* is included in this widely variable species. Branches solitary or opposite, akinetes intercalary or terminal in tiers.

*Hab.* Common all over India and Burma, often visible as floating crisp densely interwoven coarse masses of filaments during hot season, offering favourite resort for the mosquitoes to breed and larvæ to develop.

## Family—ŒDOGONIACEÆ. (Pl. XXXII, Fig. 2.)

Plants aquatic or on wet grounds, filaments simple or branched, attached at first by a holdfast at the base, cells cylindrical, slightly swollen towards the rounded or acuminate apex, which may be drawn out into a long hair; cell division intercalary, by the rupture of a ring-like thickening on either side of the inner wall of each cell at the apices and thus each division is marked by distinct apical cap at the distal end of the cell; chloroplasts parietal, reticulate with one or many pyrenoids; asexual reproduction by multiciliated zoospores formed singly by the vegetative cell, germinating after swarming without rest, akinetes rarely found in *Œdogonum* in chain; sexual reproduction by fertilisation of eggs and sperms in Oogonia and antheridia; Oogonia occurring singly or in a series formed from vegetative cells, opening by a pore or lid through which sperm may pass; Antheridia either on the same filament as the oogonia or in separate filaments that is filaments may be monœcious or diœcious, male filaments either of the same size as the female or much smaller when it is called dwarf males which are formed from the germination of androspores, dwarf males epiphytic either on or adjacent to the oogonia or sometimes scattered, sperms either one or two in each antheridium; after fertilisation the egg becomes oospore and after a period of rest produces four zoospores each of which on germination developes into new plant.

*O. oblongellum Kirch.*—a monœcious species with solitary ellipsoid oogonium, and 1-2 antheridium with the vegetative cells 16-60 μ long and 8-15 μ wide and oogonium 34-48 μ long and 20-24 μ wide.

## Family—VAUCHERIACEÆ.

Plants terrestrial or aquatic, forming expanded feltlike loosely interwoven mass composed of much elongated robust tubular sparingly branched filaments; chlorophyll granules distributed along the walls, with conspicuous oil globules without pyrenoids; asexual reproduction by multiciliate zoospores formed in the clubshaped sporangia at the swollen ends of branches, the zoospore developing new filaments after a short resting period or by formation of cysts by breaking up of the contents of filaments and each developing a thick lamellose membrane and may, in the beginning, remain attached to the mother filament thus forming the so called *Gongoosira* stage; sexual reproduction by oospores formed in the Oogonia and fertilised by ciliated anthrosoids formed in the tubular anthridia, oospore on germination giving rise to new thread.

Up till now seven species of *Vaucheria* have been reported to occur on moist grounds along the sides and flooded areas of streams or in salt and brackish water areas Of these again *V sessilis* DC and *V ornithocephala* Ag are frequently met with in marshy brackish water or estuarine areas The latter with 20 40 μ wide filaments and its characteristic somewhat beaked lateral oogonia 100 125 μ long and 60-75 μ wide and cylindrical somewhat prostrate along the thallus 30 35 μ antheridia is easily distinguished, oospore spherical or ellipsoid, 50-75 μ in diameter The thallus forming pure association of velvety deep green felt like expansions in Calcutta Salt Lakes and Port Canning and other estuarine regions

## Conjugatæ.

### Family—ZYGNEMACEÆ

Plants free floating, of simple unbranched filamentous forms composed of cylindrical cells joined end to end forming an interwoven slippery mass, the filaments either sessile or attached to the substrata by lateral or terminal sub hyaline rhizoidal outgrowths (heptera) developed from cells near the end of the filament or by a tendril-like coiling of the filament, some species of *Spirogyra* and *Zygnema* growing in flowing streams attached to rocks regularly develop holdfast (haptera) such a development is due to contact with rough surface, cell wall thick or thin with an inner layer of cellulose layer and outer layer of pectose, several species of *Spirogyra* having replicate end walls due to development of annular in growths along the adjoining walls cells uninucleate chloroplasts in each cell 1-6, spiral ribbon like bands (*Spirogyra*) with several conspicuous pyrenoids on them, a single axial plate (*Mougeotia*) and its relatives with several irregularly scattered pyrenoids and 2 stellate chloroplasts (*Zygnema*) each with a single pyrenoid Vegetative reproduction by cell division followed by immediate separation of daughter cells or by fragmentation of filaments Formation of asexual reproductive bodies (akinetes) are not definitely established Sexual reproduction by the production of zygospores as a result of conjugation by the fusion of amœboid gametes *Conjugation generally occurs between 2 filaments which arrange them*selves parallel to one another (rarely 3 6 filaments are involved in such conjugation too), such juxtaposition being due to slow movements of the filaments, the threads being, at the commencement of conjugation agglutinated by mucilage although such agglutination of the filaments are not rare without having conjugation, the threads when thus arranged in juxtaposition papillæ or conjugation tubes from opposite or corresponding points from other filament and the two papillæ thus in contact with each other gradually elongate and the threads pushed apart When the processes reach their full length the cross walls dissolve and an open conjugation tube is formed and the prolongation of the two protoplasts that have extend in the meantime are thus brought into direct touch and the process of fusion between the gametes result in a zygospore The two methods of conjugation generally observed in *Spirogyra* and *Zygnema*, are *Scalariform* (ladder like) when conjugation takes place between two

different filaments or *lateral* when conjugation takes place between two adjoining cells of the same filament. The members of the family exhibit isogamy as in *Mougeotia* or anisogamy (although more of physiological nature the gametes morphologically being indistinguishable) as in *Spirogyra* and *Zygnema*. The latter is indicated by fusion by one of the comparatively active gametes the male with the rather passive—the female and all the zygospore lodged in the female cells of the female filament. The zygote germinate into new filaments by bursting its outer wall under favourable conditions.

Genus—SPIROGYRA.

About 25 species of *Spirogyra* are recorded. Of these three commoner species are noted below :—

(1) *Spirogyra neglecta* (Hass.) Kutz.—filaments densely interwoven floating slimy bright green masses, vegetative cells 56-67 μ broad, 2-5 times as long, chlorophyl band 3 in number, 1-2½ turns in each cell, zygospores ellipsoid with broadly rounded ends, 45-64 μ in width and 1½ times as long, outer wall smooth yellowish.

(2) *Spirogyra maxima* (Hass.) Wittr.—vegetative cell 90-130 μ broa (170 μ) in width, 120-160 μ in length, conjugation tube 20-30 μ zygospores elliptic, 63-110 μ in diameter.

Family—DESMIDIACEÆ.

Plants unicellular green sometimes showing as in (*Closterium*) latory or gliding backward and forward movements characteris division of cells into two symmetrical halves, cells exhibiting grea sity in sizes, shapes and forms, often ornamental, single or joined forming more or less fragile unbranched filaments, transversely c at the centre leaving on either side deep incision (*Sinus*) of equ sion connecting, the two *semicells* by a narrow portion known at the middle or occasionally with slight or without any constr wall with minute pores, firm, smooth, beautifully sculptured with spines or worts or various ornamentations generally enve mucous covering; cell-contents (chloroplasts) granular, green many pyrenoids sometimes exhibiting circulatory movement of cells having terminal hyaline vacuoles (empty spaces) a (poles), in these polar vacuoles are often visible minute many crystals of calcium sulphate (gypsum granules) demo tory movement (Brownian movement); vegetative multipl division resulting into two new daughter cells attached eac semicell; asexual reproduction by aplanospores; sexual conjugation between two cells approaching together and p tion tubes from the two isthmuses or from the central port guous sides resulting in the fusion of aplanospores aplanog formation of zygospores; zygospores may be spher rhomboidal or of various shapes outer wall variously coloured; double zygospores or parthenospores or oth sexual reproduction are not of rare occurrence.

### Genus—PENIUM (Pl XXXII, Fig 5)

*Penium Libellula* (Focke) Nordst —cells 230-360 µ long and 35-50 µ broad cell wall smooth often of brownish colour when old, zygospores globose and smooth 45-56 µ in diameter

### Genus—CLOSTERIUM (Pl XXX, Fig 7 & 8)

*Closterium parvulum* Nag —cells strongly curved, apices acutely rounded, distances between both the apices 66-175 µ width of the cell at the centre 8 20 µ, apices 1 5-2 µ broad, cell wall smooth, zygospore 26 35 µ in diameter

*Closterium moniliferum* (Bory) Ehrenb —cell moderately curved inflated at the middle distance between the apices 212-370 µ 24-72 µ wide apices obtusely rounded 8 11 µ broad, cell wall smooth, zygospore ellipsoid, smooth

*Closterium Ralfsii* Breb —cells very elongate, moderately curved, inner margin inflated for over half the length of the cell somewhat suddenly attenuated towards the apices inter distance 315 540 µ, 42 50 µ wide at the centre, apices obtusely rounded 8 10 µ broad, cell wall brown or reddish brown, finely striated striæ 28 33 in number *C Ralsii* var *hybridum* is more frequently met with

### Genus—EUASTRUM (Pl XXXII, Fig 10)

*Euastrum inermius* (Nordstedt) Turner var burmense West —cells more or less orbicular in outline, as long as broad or slightly longer, 45 µ long isthmus 12 µ broad terminal lobes trapezoid, distinctly retuse, basal lobes subovate tumours central near the isthmus, sinus narrow linear, in side view incised at the middle apices suddenly produced, rounded, in vertical view oblong elliptic moderately inflated at the middle

### Genus—MICRASTERIAS (Pl XXXII, Fig 4)

*Micrasterias foliacea* Bailey —cells subquadrate 60-75 µ long and 80 95 µ broad semicells deeply trifid segments bifid or trifid, secondary segments irregularly incised and dentate, polar segment obovate, irregularly incised and denticulate cell wall smooth The cells of this species are frequently united end ways into ribbons though easily separated

*Micrasterias Crux-Melitensis* (Ehrenberg) Ralfs.—cells more or less suborbicular in outline, 82-126 µ long and 75-120 µ wide; semicells mainly three lobed lateral lobes bifid or sometimes trifid, margins of the lobes somewhat curved ultimate segments shortly linear [illegible] tricuspidate, apical segments rectangular oblong, concave at the [illegible] bicuspidate at both corners, vertical view subrhomboid elliptic with produced poles membrane smooth or minutely punctate

### Genus—COSMARIUM (Pl XXXI, Fig 9)

*Cosmarium granatum* Bréb.—cell suborbicular elliptic [illegible] times as long as broad 22-50 µ long and [illegible] µ wide, [illegible]

sinus linear; semicells truncate-pyramidate, basal angles rounded; lateral view elliptic ovate or obovate; vertical view elliptic, 10-18 µ in thickness cell wall of the Indian forms are nearly all smooth rarely finely punctate. This is the most common cosmopolitan species of the genus and found throughout the globe in various habitat. Several varieties are distinguished and abnormalities are also recorded.

*Cosmarium* tenue Arch.—cells nearly as long as broad, deeply constricted; 14-16 µ long, 12-16 µ broad, sinus linear opening outwards, lateral view of semicell circular; vertical view elliptic, 8-9 µ in thickness, cell wall smooth.

Genus—XANTHIDIUM. (Pl. XXXI, Fig. 10.)

*Xanthidium antilopæum* (Bréb.) Kutz.—cells as long as broad 42-76 µ long and 42-72 µ broad without spines, sinus linear with slightly dilated extremity isthmus 14-26 µ thick, semicells elliptic-hexagonal, all the angles slightly rounded, each of the four exposed angles furnished with a pair of simple, straight or slightly curved fairly long spines 12-40 µ long; central area generally round, thickened and variously scrobiculated; side view of semicells circular or subcircular, vertical view elliptic, 21-37 µ in thickness; cell wall very finely punctate. Zygospore globose with long slender spines slightly bifurcate at the apices.

Genus—ARTHRODESMUS.

*Arthrodesmus convergens* Ehrenberg.—is the most widely distributed in Indian waters. It is easily distinguished by its cells 33-54 µ long, 40-64 µ broad without spines deeply constricted, sinus widely opening outwards; isthmus 10-17 µ in thickness; semicells elliptic, each of the lateral angles furnished with a spine; spines 5-15 µ long, lateral view globose, vertical view narrowly elliptic with a short spine at each pole, 18-26 µ in thickness; cell wall smooth or delicately punctate; zygospore 39-48 µ in diameter, globose, smooth.

Genus—STAURASTRUM. (Pl. XXX, Fig. 11.)

*Staurastrum dejectum* Bréb.—cells nearly as long as broad in outline, 16-30 µ long, 17-27 µ broad without spines; isthmus 5-8 µ in thickness, spines 3-8 µ long, vertical view triangular sometimes quadrangular, sides slightly concave. angles terminated by spines.

Genus—SPHÆROZOSMA. (Pl. XXXII, Fig. 8.)

*Sphærozosma pulchrum* is a common species in the shallow lakes and jheels of the hill areas of Assam. Cells forming long tenuous somewhat tortuous filament, 10-16 µ long, 22-27 µ broad, isthmus 6 µ thick; semicells linear-oblong. side view circular, vertical view oblong elliptic with obtusely rounded poles, 10 µ in thickness.

Genus—HYALOTHECA. (Pl. XXXI, Fig. 12.)

*Hyalotheca dissiliens* (Sm.) Bréb.—cells slightly broader than long, lateral margin slightly concave in the middle: 9-33 µ long, 10-39 µ broad, zygospore 15-25 µ in diameter, globose, smooth.

## Genus—DESMIDIUM (Pl XXXII, Fig 9)

*Desmidium aplogonum* Bréb —is fairly common This species is characterised by filaments long and twisted, cells twice as broad as long, constriction open and acute, 13-20 μ long and 20-30 μ broad, isthmus 21-24 μ in thickness, end view usually triangular sometimes quadrangular, zygospore 18-26 μ in diameter The allied species *D Swartzii* Ag is not of rare occurrence The allied genus *Gymnozyga* has a representative species in India *G moniliformis* easily distinguished by more or less twisting filaments of barrel shaped cells with the semicells inflated at the base, cell wall exhibiting fine longitudinal striations and circular end view

## Family—DIATOMACEÆ

Diatoms are unicellular or sometimes colonial plants of great beauty due to their remarkable sculpturing of the silicified cell walls, cell walls of two siliceous valves one overlapping the other like the two parts of a pill box, one half of the cell (*epitheca*) fitting closely over the younger (*hypotheca*), the diatom cell and also the empty wall called " frustule ", when lying with the valve side uppermost it is said to be in *valve view*, each valve has a connecting band, the two connecting bands together forming the girdle, that fit over one another, and when lying with the connecting bands uppermost the cell is in *girdle view*, thus there are two distinct aspects of the cell of a Diatom, slight thickenings internally at the centre and at each end of the valve are known as nodules the middle one—the central nodule and the two at the ends terminal nodules, the furrow or the actual slit extending in the form of a median like through a sort of ridge between these internal central and terminal nodules—constitutes the *true raphe* as opposed to *pseudoraphe* which refers to the linear smooth axial area separating or demarcating the two systems of striæ as visible in valve view, the shapes, sizes, nature of striations and differences in valve and girdle view, vary widely, the protoplasts usually a peripheral cytoplasm with a central nucleus, smaller brownish pigments constituting the endochrome plates, the golden brown colour is due to Diatomin which marks the green constituent of the chlorophyl and is soluble in water, reproduction by ordinary nuclear division of plant cell producing like the cell of a Desmid by the separation of two halves the mother valve producing the new valve on the naked side and thus the larger parent valve overlapping the smaller daughter valve, sexual reproduction by formation of special cells (*auxospores*) resulting from gametic fusion of two similar protoplasts Auxospores however may also be produced by separation of the valve and subsequent escape of the protoplast developing when free into a new frustule, or by division of the protoplasts apogamously into two daughter protoplasts and finally like independent spores developing into new cells or sexually by conjugation of a pair of protoplasts from two contiguous cells Auxospore may thus be a naked protoplast, an asexual spore or a zygospore—all finally restored to the size of normal frustule

Locomotion of free living colonial but mostly type or Diatoms are visible under the microscope. Various theories have been advanced on

the different kinds of movements which may be exhibited as jerky or gliding motions.

*Synedra affinis* Kutz. var. *fasciculata* (Pl. XXXII, Fig. 7) frustule 70-80 μ long, and 4 μ wide, 15 markings in every 10 μ. It is extremely common in great abundance either solitary or as plankton or floating in thin film on an expanse of water in fresh and brackish water pools, lakes, rivers, etc., *S. acus* (Kutz.) Grun. is also a common species in India and Burma and this species sometimes ascend up to a height of 7,000 feet in the hills.

*Navicula viridis* Kutz. (Pl. XXXII, Fig. 6)—frustule elongate, inflated at the middle, broadly rounded at the poles, 70-80 μ long, 20-24 μ wide at the centre 15 μ wide towards the poles, 12-15 markings in 10 μ. This species is also a common Diatom in fresh water pools, tanks, ditches, lakes, etc., in the plains throughout India and Burma.

## Charales.

### Family—CHARACEÆ.

The plants are diagnosed by their Equisetum like vegetative growth exhibiting a whorled lateral branchings of limited growth anchored at the base by means of rhizoids to the substrata. The vegetative body is a profusely branched cylindric stem or main axis differentiated into short nodes and long internodes, from the nodes arise whorls of branches which are of two kinds :—one of limited growth often spoken of as leaves and the other, resembling the parent axis, are of indefinite growth. The plants are erect and grow to a height of generally 20-30 cm. or sometimes up to a metre. The basal nodes are also the points of origin of typical corticated cells formed in *Chara* and *Lychnothamnus* but entirely absent in *Nitella* and *Tolypella.* The internodal uncovered cells of *Nitella* exhibit distinctly streaming movements of protoplasm. Vegetative propagation takes place by means of tuber like outgrowths, special branches, etc., formed on the rhizoids or around the nodes of the buried parts of the main axis. The so called starch—stars are the subterranean nodes. Sexual reproduction is complicated and takes place by fertilisation of oosphere by sperms developed in an antheridium. The walls of antheridium are composed of 8 triangular plate like cells the shields. An elongated cell manubrium projects centripetally out from the centre of each shield bearing a terminal head cell. The head cell divides into a number of similar cells each of the ultimate cell gives rise to a pair of filaments, each of which containing about 200 cells and each of these cells again producing a single biciliated spirally coiled sperm. Oogonium is an enlarged apical cell replacing a secondary branch and contains a single large egg cell or ovum filled with starch and oil globules. The wall of the oogonium is invested by spirally wound elongated cells developed from the basal cell. On the top of the oogonium each of the inverting cell cuts off a conical tip cell the cluster of these crown of closely fitted tipcells is known as crown or corona. During the period of fertilisation these crown cells spread apart leaving slits of for the sperms to pass through and finally one of them fusing with the oospore (ovum) resulting in an oospore. Oospore develops an outer hard cover to pass a

resting stage After the dormant period under suitable conditions the spore germinates sending out a simple filament and an elongated rhizoidal cell From such a filament known as Pro embryo finally arises the adult shoot as a lateral branch

Out of about forty species of Characeæ recorded the common species are —

1 *Nitella mirabilis* Nordstedt —diœcious species stem 500 µ in diameter whorls of 6 8 µ long branches branchlets once furcate oogonia clustered 2 3 together a few solitary conspicuously stalked up to 5 mm long 550 700 µ long and 475 575 µ broad spiral cells showing 8 convolutions crown cells broadly conical 50 µ high 75 µ broad deciduous antheridia 2 3 clustered 500 600 µ in diameter oospores 300 µ thick deep golden brown in shallow pools in Upper India

2 *Nitella acuminata* Braun —antheridia 275 µ in diameter oogonia often clustered 275 310 µ long and 250 275 µ broad and 175 225 µ thick This species is widely distributed throughout India and Burma ascending 4 000 feet in the Simla Hills

*Chara zeylanica* Willd —coronula straight to broadly spreading oospore 600 725 µ long spine cells short and scarcely visible on some stems The forms vary widely occurring throughout India and Burma

*Chara fragilis* Desv —a worldwide species occurring throughout Upper India and ascending the hills of Kashmir and the Sikkim Himalayas up to an elevation of 16 000 feet

*Chara branchupus* Braun —is another widely distributed species in India and Burma

# EXPLANATION OF FIGURES.

## PLATE I

FIG 1 —Nymphæa rubra —(*a*) Portion of a plant with leaves and open flowers (*b*) longitudinal section through the torus, (*c*) transverse section through the ovary

FIG 2 —Nymphæa lotus —(*a*) Portion of a plant with leaves and open flowers (*b*) longitudinal section through the torus, (*c*) transverse section through the ovary

FIG 3 —Nymphæa stella —(*a*) Portion of a plant with leaves and open flowers (*b*) structure of the staminal whorl

FIG 4 —Nymphæa cyanea —(*a*) Portion of a plant with leaves and open flowers (*b*) base of the plant with young leaf buds (*c*) longitudinal section through the torus (*d*) transverse section through the ovary

## PLATE II

FIG 1 —Euryale ferox —(*a*) Two full sized leaves, (*b*) a flower (*c*) longitudinal section through an open flower (*d*) transverse section through a fruit (*e*) longitudinal section through a fruit (*f*) seeds

FIG 2 —Nelumbium speciosum var rubra —(*a*) Trailing rhizome with leaf buds (*b*) full sized leaves, (*c*) open flowers and a flower bud (*d*) torus with a bunch of stamens, (*e*) surface of torus showing the position of the seeds embedded in the torus, (*f*) longitudinal section through the torus and the seed

FIG 3 —Ceratophyllum demersum —(*a*) A young plant, (*b*) portion of submerged floating shoot, (*c*) capillary leaves (*d*) ovary and style (*e*) a winter bud or turion, (*f*) a seed

FIG 4 —Nelumbium speciosum (var typica white) (alba) —(*a*) Trailing rhizome with leaf buds (*b*) full sized leaves (*c*) open flowers and a flower bud (*d*) torus with a bunch of staminal whorl and portion of a torus longitudinally cut open (*e*) a seed

## PLATE III

FIG 1 —Trapa bispinosa —(*a*) Portion of a plant (*b*) portion of stem with roots and capillary leaves (*c*) one half of a flower dissected longitudinally (*d*) fruits longitudinally cut open

FIG 2 —Lagarosiphon Roxburghii —(*a*) Portion of the floating stem with adventitious roots developing from the nodes (*b*) portion of the shoot with well developed leaves more or less crowded towards the apices (*c*) a flower (*d*) a flower bud and a flower with two stamens (*e*) ovary and its transverse section

FIG 3 —Leersia hexandra —(*a*) Portion of flowering plant with leaves and roots at the nodes (*b*) a rather spreading panicle, (*c*) an open flower (*d*) a flower dissected showing the lodicule stamens and ovary with style and stigma

FIG 4 —Nymphæa esculenta —(*a*) A basal portion of a plant showing rhizome leaf buds and a flower bud, (*b*) full sized leaves and open flowers (*c*) longitudinal section through the torus showing the arrangement of stamens and pistil (*d*) transverse section through the ovary

## PLATE IV

FIG 1 —Oryza sativa —(*a*) Portion of the plant with the root (*b*) a panicle, (*c*) an open flower (*d*) a stamen (*e*) a fruit with awn

FIG 2 —Aeschynomene aspera —(*a*) Portion of the shoot (?) parts of a flower dissected (?) a fruit longitudinally cut open showing the attachment of the seed

FIG 3 —Aeschynomene indica —(*a*) Portion of the plant with root stem leaves (*b*) an open flower with leaf and basal stipules (*c*) a fruit (*d*) a fruit longitudinally cut open showing the position of the seeds

FIG 4 —Neptunia oleracea —(*a*) Portion of the plant with root stem leaves and fruits (*b*) a bunch of floaters or respiratory organs (?) (*c*) an open flower (*d*) a seed burst open



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## PLATE V.

FIG. 1.—*Ipomœa aquatica*.—(*a*) Portion of the plant with root, stem and leaves; (*b*) part of the flower dissected to show the position of stamens and pistil.

FIG. 2.—*Limnanthemum indicum*.—(*a*) Portion of the plant with leaves and inflorescence; (*b*) corolla spread out showing the position of stamens in relation to the petals; (*c*) pistil with basal calyx lobes; (*d*) transverse section through an ovary showing the ovules attached to the placenta.

FIG. 3.—*Limnanthemum cristatum*.—(*a*) Basal portion of the plant showing the nature of the root; (*b*) upper portion of the plant, leaves and flowers; (*c*) a leaf bearing at its axil flower buds and open flowers; (*d*) a flower spread out; (*e*) petals separated showing the attachment of the stamens; (*f*) pistil with calyx lobes; (*g*) transverse section of the ovary and a seed.

FIG. 4.—*Aldrovanda vesiculosa*.—(*a*) Portion of the plant; (*b*) a whorl of leaves and an open flower; (*c*) a seed; (*d*) transverse section of the ovary.

## PLATE VI.

FIG. 1.—*Oenanthe bengalensis*.—(*a*) a plant with roots, leaves and flowers; (*b*) an umbellate inflorescence; (*c*) an open flower; (*d*) fruit and its transverse section.

FIG. 2.—*Enhydra fluctuans*.—(*a*) Portion of a plant; (*b*) an axillary flower head; (*c*) a disk-floret; (*d* & *d'*) florets; (*e*) cypsila (seed).

FIG. 3.—*Hydrolea zeylanica*.—(*a*) Portion of a plant with roots, leaves and flowers; (*b* & *b'*) open flowers showing ventral and dorsal sides of calyx and corolla; (*c*) Pistil with calyx lobes; (*d*) transverse section of ovary.

FIG. 4.—*Limnophila Roxburghii*.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) petals dissected out showing position of stamens; (*c*) pistil with calyx lobes; (*d*) transverse section of the ovary; (*e*) seed.

## PLATE VII.

FIG. 1.—*Limnophila conferta*.—(*a*) a plant with roots, leaves and flowers; (*b*) a leaf enlarged; (*c*) a flower longitudinally cut open; (*d*) a pistil with calyx lobes; (*e*) transverse section through the ovary.

FIG. 2.—*Limnophila hypericifolia*.—(*a*) Portion of a plant with leaves and flowers; (*b*) a flower; (*c* & *d*) a flower cut open showing the calyx and corolla lobes, stamens and pistil; (*e*) stamens; (*f*) transverse section through the ovary; (*g*) longitudinal section of the ovary; (*h*) a fruit burst open with calyx lobes attached at the base.

FIG. 3.—*Utricularia reticulata*.—(*a*) Two plants with roots, leaves and flowers; (*b*) a flower bud and an open flowers; (*c*) a flower opened out showing the different parts; (*d*) a pair of stamens; (*e*) capsule; (*f*) seed showing reticulation.

FIG. 4.—*Utricularia Wallichiana*.—(*a*) Full sized plant with roots and flowers; (*b*) a flower with adjacent portion of a stem and leaves; (*c*) portions of flower dissected out; (*d*) stamens; (*e*) pistil; (*f*) transverse section through the ovary; (*g*) seed showing reticulation.

## PLATE VIII.

FIG. 1.—A. *Myriophyllum tuberculatum*.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) single flower; (*c* & *c'*) fruits and their different sections. B. *Potamogeton indicum*.—(*a*) Portion of a plant with roots, leaves and inflorescence; (*b*) single flower; (*c*) different parts of flowers dissected; (*d*) a seed and its longitudinal section showing the embryo.

FIG. 2.—*Limnophila heterophylla*.—(*a*) Portion of plant; (*b*) single flower; (*c*) a flower cut open showing the position of stamens and pistil; (*d*) transverse section of an ovary; (*e*) a seed.

FIG. 3.—*Limnophila racemosa*.—(*a*) Portion of plant with roots, leaves and inflorescence; (*b* & *c*) a flower cut open showing the position of stamens and pistils; (*d*) a fruit with calyx lobes; (*e*) transverse section of the fruit.

FIG. 4.—*Herpestis Monniera*.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) single flower; (*c*) a flower cut open showing the different parts; (*d* & *d'*) ovary and its transverse section with an ovule separated out.

## PLATE IX

FIG 1—*Dopatrium nudicaule*—(a) Several plants with roots, leaves and flowers showing the nature of growth, (b) single flower, (c) a flower cut open, (d & d) fruit and its transverse section

FIG 2—*Dopatrium lobelioides*—(a) A plant with roots leaves and flowers, (b) a flower, (c) a flower cut open showing the different parts, (d & d) a fruit and its transverse section

FIG 3—*Utricularia stellaris*—(a) Portion of plant with leaves and inflorescence (b) a flower (c & c) fruits and transverse section of one of them, (d) portion of inflorescence and attached fruits, (e) diagram illustrating the respective position of the floral organs

FIG 4—*Alternanthera sessilis*—(a) Portion of plant with roots leaves and flowers, (b) inflorescence (c & c') a flower and its stamens and pistil separated (d) a fruit and its transverse section

## PLATE X

FIG 1—*Utricularia racemosa*—(a) A plant with roots leaves and flowers, (b) an open flower (c) different parts of the flower separated (d) stamen showing ventral and dorsal view (e) fruit and its longitudinal section (f) transverse section of fruits and seeds separated out showing coarse scrobiculations

FIG 2—*Hygrophila spinosa*—(a) Portion of plant with leaves and flowers (b) an open flower (c) a flower dissected out (d) two fruits one unopened on the left hand side the other opened showing seeds intact and one of them separated out

FIG 3—*Acanthus ilicifolius*—(a) Portion of plant with leaves and flowers (b) bracts, (b) a flower, (c) a flower cut open showing the pistil, (d) a fruit burst open, (e) a seed

FIG 4—*Salicornia brachiata*—(a) Portion of plant showing decussate branches (b) part of the inflorescence (c) part of the inflorescence enlarged, (d) flower opened out showing the position of the only stamen and pistil and the fruit

## PLATE XI

FIG 1—*Ranunculus sceleratus*—(a) single plant with roots leaves and flowers (b) flowers, (c) torus with apocarpus ovary (d) fruit with calyx lobes, (e) longitudinal and transverse section through the ovary

FIG 2—*Bythophyton indicum*—(a) Portion of plant with leaves and flowers, (b) flower and bracts (c) a flower cut open (d) fruit with calyx lobes

FIG 3—*Podostemon Wallichii*—(a) Portion of the plant with fruits, (b) portion of plant with flower and fruit (c) transverse section of the ovary (d) a seed, (e) transverse and longitudinal section of the ovule showing the embryo

FIG. 4—*Utricularia bifida*—(a) Two plants with roots leaves and flowers (b) leaf enlarged (c) fruit and its longitudinal section, (d) transverse section through the ovary, (e) seed with reticulations

## PLATE XII

FIG 1—*Polygonum glabrum*—(a) Portion of plant with roots leaves and inflorescence; (b) a flower cut open (c & c) fruits (d) transverse section of the fruit

FIG 2—*Polygonum lanigerum*—(a) Portion of the plant with roots leaves and inflorescences (b) flower cut open (c & c') fruits, (d) transverse section of the fruit

FIG 3—*Polygonum barbatum*—(a) Portion of the plant (b) flower cut open (c & c') fruits (d) transverse section of the fruit

FIG 4—*Jussiæa repens*—(a) Portions of plant (b) flower opened out, (c) fruit

## PLATE XIII

FIG 1—*Hydrocharis morsus—ranae*—(a) Portion of plant with roots leaves and flowers (b & b) bunch of flowers (c) staminal whorls of stamens separated, (d) flower, (e & e) ovary and its transverse sections, (f) seeds

FIG 2—*Alpinia Allughas*—(a) Portion of the plant with leaves and inflorescence, (b) flower bud (c) open flower (d & d) flower cut open, (e) fruit (f) Transverse section of the fruit (g) seed

## PLATE V.

FIG. 1.—Ipomœa aquatica.—(*a*) Portion of the plant with root, stem and leaves; (*b*) part of the flower dissected to show the position of stamens and pistil.

FIG. 2.—Limnanthemum indicum.—(*a*) Portion of the plant with leaves and inflorescence; (*b*) corolla spread out showing the position of stamens in relation to the petals; (*c*) pistil with basal calyx lobes; (*d*) transverse section through an ovary showing the ovules attached to the placenta.

FIG. 3.—Limnanthemum cristatum.—(*a*) Basal portion of the plant showing the nature of the root; (*b*) upper portion of the plant, leaves and flowers; (*c*) a leaf bearing at its axil flower buds and open flowers; (*d*) a flower spread out; (*e*) petals separated showing the attachment of the stamens; (*f*) pistil with calyx lobes; (*g*) transverse section of the ovary and a seed.

FIG. 4.—*Aldrovanda vesiculosa*.—(*a*) Portion of the plant; (*b*) a whorl of leaves and an open flower; (*c*) a seed; (*d*) transverse section of the ovary.

## PLATE VI.

FIG. 1.—Oenanthe bengalensis.—(*a*) a plant with roots, leaves and flowers; (*b*) an umbellate inflorescence; (*c*) an open flower; (*d*) fruit and its transverse section.

FIG. 2.—Enhydra fluctuans.—(*a*) Portion of a plant; (*b*) an axillary flower head; (*c*) a disk-floret; (*d* & *d'*) florets; (*e*) cypsila (seed).

FIG. 3.—Hydrolea zeylanica.—(*a*) Portion of a plant with roots, leaves and flowers; (*b* & *b'*) open flowers showing ventral and dorsal sides of calyx and corolla; (*c*) Pistil with calyx lobes; (*d*) transverse section of ovary.

FIG. 4.—Limnophila Roxburghii.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) petals dissected out showing position of stamens; (*c*) pistil with calyx lobes; (*d*) transverse section of the ovary; (*e*) seed.

## PLATE VII.

FIG. 1.—Limnophila conferta.—(*a*) a plant with roots, leaves and flowers; (*b*) a leaf enlarged; (*c*) a flower longitudinally cut open; (*d*) a pistil with calyx lobes; (*e*) transverse section through the ovary.

FIG. 2.—Limnophila hypericifolia.—(*a*) Portion of a plant with leaves and flowers; (*b*) a flower; (*c* & *d*) a flower cut open showing the calyx and corolla lobes, stamens and pistil; (*e*) stamens; (*f*) transverse section through the ovary; (*g*) longitudinal section of the ovary; (*h*) a fruit burst open with calyx lobes attached at the base.

FIG. 3.—*Utricularia reticulata*.—(*a*) Two plants with roots, leaves and flowers; (*b*) a flower bud and an open flowers; (*c*) a flower opened out showing the different parts; (*d*) a pair of stamens; (*e*) capsule; (*f*) seed showing reticulation.

FIG. 4.—Utricularia Wallichiana.—(*a*) Full sized plant with roots and flowers; (*b*) a flower with adjacent portion of a stem and leaves; (*c*) portions of flower dissected out; (*d*) stamens; (*e*) pistil; (*f*) transverse section through the ovary; (*g*) seed showing reticulation.

## PLATE VIII.

FIG. 1.—A. Myriophyllum tuberculatum.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) single flower; (*c* & *c'*) fruits and their different sections. B. Potamogeton indicum.—(*a*) Portion of a plant with roots, leaves and inflorescence; (*b*) single flower; (*c*) different parts of flowers dissected; (*d*) a seed and its longitudinal section showing the embryo.

FIG. 2.—Limnophila heterophylla.—(*a*) Portion of plant; (*b*) single flower; (*c*) a flower cut open showing the position of stamens and pistil; (*d*) transverse section of an ovary; (*e*) a seed.

FIG. 3.—Limnophila racemosa.—(*a*) Portion of plant with roots, leaves and inflorescence; (*b* & *c*) a flower cut open showing the position of stamens and pistils; (*d*) a fruit with calyx lobes; (*e*) transverse section of the fruit.

FIG. 4.—Herpestis Monniera.—(*a*) Portion of plant with roots, leaves and flowers; (*b*) single flower; (*c*) a flower cut open showing the different parts; (*d* & *d'*) ovary and its transverse section with an ovule separated out.

# EXPLANATION OF FIGURES.

## PLATE IX.

FIG 1 —Dopatrium nudicaule —(*a*) Several plants with roots, leaves and flowers showing the nature of growth, (*b*) single flower, (*c*) a flower cut open, (*d* & *d*) fruit and its transverse section

FIG 2 —Dopatrium lobelioides —(*a*) A plant with roots leaves and flowers, (*b*) a flower, (*c*) a flower cut open showing the different parts, (*d* & *d'*) a fruit and its transverse section

FIG 3 —Utricularia stellaris —(*a*) Portion of plant with leaves and inflorescence, (*b*) a flower (*c* & *c*) fruits and transverse section of one of them, (*d*) portion of inflorescence and attached fruits (*e*) diagram illustrating the respective position of the floral organs

FIG 4 —Alternanthera sessilis —(*a*) Portion of plant with roots leaves and flowers, (*b*) inflorescence, (*c* & *c*) a flower and its stamens and pistil separated, (*d*) a fruit and its transverse section

## PLATE X

FIG 1 —Utricularia racemosa.—(*a*) A plant with roots leaves and flowers, (*b*) an open flower, (*c*) different parts of the flower separated (*d*) stamen showing ventral and dorsal view, (*e*) fruit and its longitudinal section, (*f*) transverse section of fruits and seeds separated out showing coarse scrobiculations

FIG 2 —Hygrophila spinosa —(*a*) Portion of plant with leaves and flowers, (*b*) an open flower (*c*) a flower dissected out (*d*) two fruits one unopened on the left hand side the other opened showing seeds intact and one of them separated out

FIG 3 —Acanthus ilicifolius —(*a*) Portion of plant with leaves and flowers, (*b*) bracts, (*b'*) a flower (*c*) a flower cut open showing the pistil, (*d*) a fruit burst open, (*e*) a seed

FIG 4 —Salicornia brachiata —(*a*) Portion of plant showing decussate branches, (*b*) part of the inflorescence (*c*) part of the inflorescence enlarged, (*d*) flower opened out showing the position of the only stamen and pistil and the fruit

## PLATE XI

FIG 1 —Ranunculus sceleratus —(*a*) single plant with roots leaves and flowers, (*b*) flowers, (*c*) torus with apocarpus ovary, (*d*) fruit with calyx lobes (*e*) longitudinal and transverse section through the ovary

FIG 2 —Bythophyton indicum —(*a*) Portion of plant with leaves and flowers, (*b*) flower and bracts (*c*) a flower cut open, (*d*) fruit with calyx lobes

FIG 3 —Podostemon Wallichii —(*a*) Portion of the plant with fruits, (*b*) portion of plant with flower and fruit (*c*) transverse section of the ovary, (*d*) a seed, (*e*) transverse and longitudinal section of the ovule showing the embryo

FIG. 4 —Utricularia bifida —(*a*) Two plants with roots leaves and flowers, (*b*) leaf enlarged (*c*) fruit and its longitudinal section, (*d*) transverse section through the ovary (*e*) seed with reticulations

## PLATE XII

FIG 1 —Polygonum glabrum —(*a*) Portion of plant with roots leaves and inflorescence; (*b*) a flower cut open (*c* & *c'*) fruits (*d*) transverse section of the fruit.

FIG 2 —Polygonum lanigerum —(*a*) Portion of the plant with roots leaves and inflorescences (*b*) flower cut open (*c* & *c'*) fruits, (*d*) transverse section of the fruit

FIG 3 —Polygonum barbatum —(*a*) Portion of the plant, (*b*) flower cut open, (*c* & *c'*) fruits, (*d*) transverse section of the fruit

FIG 4 —Jussiæa repens —(*a*) Portions of plant (*b*) flower opened out, (*c*) [illegible]

## PLATE XIII

FIG 1 —Hydrocharis morsus—ranae —(*a*) Portion of plant with roots, leaves and [illegible] (*b* & *b'*) bunch of flowers, (*c*) staminal whorls of [illegible] (*d*) flower (*e* & *e'*) ovary and its transverse sections, (*f*) [illegible]

FIG 2 —Alpinia Allughas —(*a*) Portion of the plant with leaves and [illegible] flower bud, (*c*) open flower (*d* & *d'*) flower cut open, (*e*) [illegible], (*f*) [illegible] section of the fruit, (*g*) seed

## PLATE XIII—*contd.*

FIG. 3.—*Boottia cordata.*—(*a*) Plant with roots, leaves and inflorescences; (*b*) flowers dissected; (*c*) flower dissected; (*d*) transverse section of the ovary.

FIG. 4.—*Aneilema Hamiltonianum.*—(*a*) Portion of plant with leaves and flowers; (*b*) single flowers; (*c*) fruit; (*d*) showing dehiscence of the fruit.

## PLATE XIV.

FIG. 1.—*Lemna polyrrhiza.*—(*a*) Plants with roots and cladodes; (*b*) plant body highly enlarged showing development of roots; (*c*) flower; (*d*) root tip; (*e*) stomata.

FIG. 2.—*Lemna trisulca.*—(*a*) Plants with roots and cladodes; (*b*) flower; (*c*) fruit and its longitudinal section; (*d* & *e*) seed and its transverse section.

FIG. 3.—*Alisma Plantago.*—(*a*) Plant with roots, leaves and inflorescence; (*b* & *b'*) flowers; (*c*) stamens; (*d*) ovary; (*e*) seed.

FIG. 4.—*Alisma oligococcum* with leaves and floral stalk.

## PLATE XV.

FIG. 1.—*Wolffia arrhiza.*—(*a* & *b*) Plants with roots and cladodes; (*c*) a plant with a flower; (*d*) flowers; (*e*) seeds.

FIG. 2.—*Isoetes coromandeliana.*—(*a*) Plant with roots and leaves with basal inflation enclosing sporocarps; (*b* & *b'*) Sporocarp attached to the concave inner walls of the leaves with the sporocarp separated out on the left.

FIG. 3.—*Alisma reniforme.*—(*a*) Portion of plant—a leaf of the inflorescence; (*b*) flower and its parts separated out; (*c*) fruits; (*d*) a fruit burst open.

FIG. 4.—*Marsilea quadrifolia.*—(*a*) Portion of plant with roots, leaves and bundles of sporocarps; (*b*) part of plant with sporocarps at the base of the leaves attached to the creeping rhizome (stem); (*c*) transverse section of the sporocarp showing the arrangement of the Micro and Macro spores.

## PLATE XVI.

FIG. 1.—*Cardanthera triflora.*—(*a*) Portion of the plant with roots, leaves and flowers; (*b*) open flowers; (*c* & *c'*) flower and its stamens and pistils separated out; (*d*) fruits unopened and open.

FIG. 2.—*Monochoria hastæfolia.*—(*a*) Plant with rhizome, roots, leaves and inflorescences; (*b*) flowers showing posterior and anterior views; (*c*) stamens; (*d*) fruit; (*e*) transverse section of the fruit.

FIG. 3.—*Monochoria vaginalis.*—(*a*) Plant with roots, leaves and inflorescences; (*b*) flowers showing posterior and anterior views; (*c*) fruit; (*d*) transverse section of fruit.

FIG. 4.—*Cyperus distans.*—(*a*) Portion of plant with roots and leaves; (*b*) portion of the inflorescence; (*c*) flower; (*d*) seed and its transverse section.

## PLATE XVII.

FIG. 1.—*Pistia Stratiotes.*—(*a*) Plant with roots, an offset and leaves; (*b*) flowers; (*c*) flowers cut open; (*d*) fruit and its transverse section showing the ovules.

FIG. 2.—*Limnophyton obtusifolium.*—(*a*) Portions of plant with roots and leaves; (*b* & *b'*) flowers; (*c* & *c'*) ovary and its longitudinal section; (*d* & *d'*) fruit and its transverse section.

FIG. 3.—*Colocasia Antiquorum.*—(*a*) Plant with roots and leaves; (*b*) inflorescence; (*c*) floral organs separated.

FIG. 4.—*Sagittaria sagittifolia.*—(*a*) Portion of plant with roots, basal buds, leaves and inflorescence; (*b*) portion of the petiole enlarged; (*c* & *d*) longitudinal section through the ovary.

## PLATE XVIII.

FIG. 1.—*Suæda maritima.*—(*a*) Portion of plant with leaves and inflorescences; (*b*) Leaves enlarged; (*c*) flower buds and flowers; (*d* & *d'*) flowers opened and separated out; (*e*) seed.

FIG. 2.—*Polygonum orientale.*—(*a*) Portion of plant with leaves and inflorescence; (*b*) part of the stem enlarged showing the hairy ochreate stipules; (*c*) portion of the inflorescence separated showing the position of flowers; (*d*) flower dissected; (*e*) fruit and its transverse section.

## PLATE XVIII—contd

FIG 3—Xyris indica—(a) Portion of plant with roots, leaves and influrece, (b) flower (c & d) fruits

FIG 4—Nipa fruticans—(a) Portion of plant with leaves and inflorescences; (b) a leaf, (c e) inflorescences, (f) stamens, (g & h) fruit and its transverse section

## PLATE XIX

FIG 1—Polygonum serrulatum—(a) Portion of plant with leaves and inflorescences; (b) portion of stipule, (c) part of the inflorescence, (d) a flower opened out; (e) fruit and its transverse section

FIG 2—Polygonum tomentosum—(a) Portion of plant with roots leaves and inflorescences; (b) portion of the inflorescence, (c) flower, (d) fruits and transverse section of a fruit

FIG 3—Rumex maritimus—(a) Portion of plant with roots, leaves and inflorescences, (b) portion of the inflorescence, (c) bunch of flowers opened and unopened; (d) fruits and its longitudinal section

FIG 4—Lemna minor—(a) & (b) Plants with roots and cladodes, (b) flowers, (d & e) stamens, (f) pollens, (g) ovary, (h) stomata

## PLATE XX

FIG 1—A Utricularia exoleta—(a) Portion of plant with leaves and inflorescences, (b) a bladder, (c) flower longitudinally cut open, (d) flower longitudinally cut open, (d) fruit, (e) transverse section of the fruit

B Utricularia flexuosa—(a) Portion of plant with leaves and inflorescences; (b) leaf with a bladder, (c & c') flowers and its parts, (d) fruit transversely cut

FIG 2—Cryptocoryne retrospiralis—(a) Plant with roots leaves and basal flowers and with portions of leaf manified, (b) a flower longitudinally opened, (c & d) longitudinal and transverse sections of fruit

FIG 3—Cryptocoryne ciliata—(a) Plant with roots, rhizome leaves and flowers and basal fruits, (b) ciliated portion of the spathe, (c) a flower cut open; (d) longitudinal and transverse sections of fruit (e) seed

FIG 4—Cryptocoryne spiralis with roots runners and leaves

## PLATE XXI

FIG 1—Commelina salicifolia—(a) & (a') Plant and a portion of the stem (enlarged) with roots leaves and inflorescences, (b & c) flower entire and separated; (d) fruit and its transverse section

FIG 2—Typha elephantina—(a) upper portion of the plant with the inflorescence; (b) transverse section of the leaf showing width and thickness; (c) flowers; (d) flowers

FIG 3—Lagenandra toxicaria—(a) Portion of the plant with roots, rhizome leaves and inflorescence (b) spadix, (d) different kinds of flowers, (d) seed

FIG 4—Lasia heterophylla—(a) Plant with rhizome, leaves and spadix, (b) part of the stem (c) flowers (d) seeds

## PLATE XXII

FIG 1—Eleocharis fistulosa—(a) Portion of the plant with roots leaves and basal runners (b) inflorescences, (b') glume (bract), (c) flower

FIG 2—Eleocharis spiralis—(a) Portion of plant with roots leaves and basal runner; (b) inflorescence (b') glume (bract) (c) flower

FIG 3—Eleocharis tuberosa—(a) Portion of the plant with roots basal runners carrying buds and leaves (b) inflorescences, (c) glume (bract), (d) flower

FIG 4—Scirpus articulatus—(a) Portion of plant with roots and inflorescence, (b) inflorescence enlarged, (c) glume (bract), (d) flower, (e) fruit, (f) transverse section of fruit

## PLATE XXIII

FIG 1.—Sagittaria guayanensis—(a) Plant with roots leaves and inflorescence, (b) flower and its parts (c & d) fruit and its longitudinal and transverse sections.

FIG 2—Aponogeton crispum—(a) Plant with roots rhizome leaves and inflorescence; (b) flower

## PLATE XXIII—*contd.*

FIG. 3.—Aponogeton monostachyon.—(*a*) Plant with roots, rhizome, leaves and its portion enlarged with inflorescence; (*b*) part of the inflorescence; (*c*) flower; (*c'*) ovary longitudinally cut open showing the ovules; (*d*) fruits and their longitudinal and transverse sections.

FIG. 4.—Naias minor.—(*a*) Portion of plant with leaves; (*b*) bunch of leaves enlarged; (*c*) flower; (*d*) fruit.

## PLATE XXIV.

FIG. 1.—Scirpus articulatus.—(*a*) Plant with roots and inflorescence; (*b*) inflorescence enlarged; (*c*) glume (bract); (*d*) flower; (*d'*) fruit and its transverse section.

FIG. 2.—Scirpus articulatus (a bent form).—(*a*) Plant with roots and inflorescences; (*b*) flower; (*c*) bract; (*d*) fruit.

FIG. 3.—Scirpus grossus.—(*a*) Plant with roots, leaf and inflorescence; (*b*) glume (bract); (*c*) part of inflorescence slightly enlarged; (*d*) flower; (*e*) fruit and its transverse section.

FIG. 4.—Serpicula indica.—(*a*) Plant with roots, leaves and flowers; (*b*) flower cluster; (*b'*) flower and its different parts separated; (*c*) fruits and its longitudinal sections and seeds.

## PLATE XXV.

FIG. 1.—Eriocaulon Sieboldianum.—(*a*) Plant with roots, leaves and flower heads; (*b* & *c*) flowers.

FIG. 2.—Paspalum scrobiculatum.—(*a* & *b*) Plant with roots, leaves and inflorescences; (*c*) part of the spike enlarged; (*d*) flower; (*e* & *e'*) seeds.

FIG. 3.—Eriocaulon quinquangulare.—(*a*) Plant with roots, leaves and flower heads and a head slightly enlarged; (*b* & *c*) flowers and their different parts separated out; (*d*) fruit, its transverse section and seed.

FIG. 4.—Panicum indicum.—(*a*) Portion of plant with roots, runner, and leaves and inflorescence; (*b*) flower; (*c*) a stamen; (*d*) fruit.

## PLATE XXVI.

FIG. 1.—Cyperus tagetum.—(*a*) & (*b*) Plant with roots, leaves and inflorescence; (*c*) part of the inflorescence enlarged; (*d*) glume (bract); (*e*) flower; (*f*) fruit and its transverse section.

FIG. 2.—Cyperus procerus.—(*a*) Portion of plant in inflorescence; (*b*) part of the inflorescence enlarged; (*c*) glume (bract); (*d*) flower; (*e*) fruit.

FIG. 3.—Cyperus articulatus.—(*a* & *b*) Portion of the plant base and apex with roots and inflorescence; (*c*) part of the inflorescence slightly enlarged; (*d*) glume (bract); (*e*) flower; (*f*) fruit and its transverse section.

FIG. 4.—Cyperus tagetiformis.—(*a* & *b*) Portion of the base and apex of the plant showing branched inflorescence; (*c*) part of the inflorescence enlarged; (*d*) glume; (*e*) flower; (*f*) fruit; (*g*) transverse section of the fruit.

## PLATE XXVII.

FIG. 1.—Cyperus corymbosus.—(*a*) Portion of the plant base and apex with roots, basal runner and branched inflorescence; (*b*) portion of the inflorescence slightly enlarged; (*c*) glume (bract); (*d*) flower; (*e*) fruit; (*f*) transverse section of the fruit.

FIG. 2.—Eleocharis plantaginea.—(*a*) Plant with roots, runner and apical inflorescence; (*b* & *c*) portion of the inflorescence slightly enlarged; (*d*) glume (bract); (*e*) flower.

FIG. 3.—A. Eleocharis spiralis.—(*a*) Portion of the plant base and apex with apical inflorescence; (*b*) inflorescence enlarged; (*c*) glume; (*d*) flower.

B. Scirpus maritimus var. affinis.—(*a*) Portion of plant with leaves; (*b*) inflorescence enlarged; (*c*) glume (bract); (*d*) flower; (*e*) stamen.

FIG. 4.—Scirpus tumidus.—(*a*) Portion of plant base and apex with roots, runner and apical inflorescence; (*b*) inflorescence enlarged; (*c*) glume (bract); (*d*) flower.

## PLATE XXVIII.

FIG 1 —Sesbania paludosa —(a) Portion of plant with leaves and flowers, (a') a pair of leaflets separated and enlarged, (b) portion of fistular stem with roots; (c) open flower showing corolla, (c') calyx lobes with fruit.

FIG 2 —Vallisneria spiralis —(a) Plant with roots, leaves and flowers; (b) basal portion of the plant with inflorescence stretched out, (c) flowers, (d) flower enlarged with stamens separated, (e) flower opened out

FIG 3 —Trapa natans —(a) Portion of plant with floating whorl of leaves, (b) flowers, (c) fruit, (d) longitudinal section of fruit

FIG 4 —Hydrilla verticillata —(a & a') Portion of young and old plant, (a') young plant with roots and leaves (a) older plant without roots but with leaves flowers, (b) an open flower, (c & c') flowers separated; (d) fruit, (e) seeds

## PLATE XXIX

FIG 1 —Acorus calamus —(a) Portion of plant with leaves and inflorescence, (b-c) open flowers, (d) section through ovary, (e) single stamen

FIG 2 —Acrostichum aureum —(a) Portion of sporophyll, (b) portion of fertile frond showing sori, (c) a sporangium

FIG 3 —A Salvinia natans —A bunch of plant
B Salvinia cucullata —Bunches of plant

FIG 4 —A Azolla pinnata —(a b) Bunches of plant, (c) with a sporocarp.
B Ricciocarpus natans —(a b) Portions of Thalli, (c) a section of the thallus

## PLATE XXX

FIG 1 —Microcystis æruginosa
FIG 2 —Oscillatoria princeps —Apical portion of filament × 300
FIG 3 —Oscillatoria tenuis
FIG 4 —Oscillatoria amphibia —(a) Apical portion of filament × 1,000, (b) portion of filament showing cells with refringent granules × 1,500
FIG 5 —Oscillatoria splendida
FIG 6 —Spirulina major
FIG 7 —Lyngbya ærugineo-coerulea
FIG 8 —Anabæna spherica
FIG 9 —Glœtrichia natans
FIG 10 —Gonicum pectorale.
FIG 11 —Pandorina morum —8 celled colony × 650
FIG 12 —Pediastrum simplex —8 celled colony × 800
FIG 13 —Chlorella vulgaris —Few assorted cells × 500
FIG 14 —Volvox æurens —Single colony × 125
FIG 15 —Pediastrum tetras —16 celled colony × 1,000
FIG 16 —Scenedesmus acuminatus —4 8 celled colonies × 1 000

## PLATE XXXI

FIG 1 —Scenedesmus perforatus —8 celled colonies
FIG 2 —Tribonema bombycinum
FIG 3 —Cladophora glomerata
FIG 4 —Cladophora crispata var genuina —Portion of filament showing the nature of branching × 100
FIG 5 —Hydrodictyon reticulatum —Portion of net × 300
FIG 6 —Pediastrum duplex var clathratum —32 celled colony × 500
FIG 7 —Closterium moniliferum —Single plant × 450
FIG 8 —Closterium Ralfsii var hybridum —Single cell × 250
FIG 9 —Cosmarium granatum
FIG 10 —Xanthidium antilopæum
FIG 11 —Staurastrum dejectum —A front view of a different type of cell than ordinarily met with, (b) top view × 600
FIG 12 —Hyalotheca dissiliens

## PLATE XXXII.

FIG. 1.—Pithophora œdogonia, var. Vaucherioides.—Portion of the branched thallus with akinetes × 100.

FIG. 2.—Oedogonium oblongellum.—(*a-b*) Portions of filaments with antheridia and oogonia × 520.

FIG. 3.—Scenedesmus quadricauda.—(*a-b*) 2-4 celled colony × 500.

FIG. 4.—Microsterias crux-Melitensis.—Front view of empty cell × 400.

FIG. 5.—Penium Lebellula.—Two young plants of variable dimensions × 80.

FIG. 6.—Navicula viridis.—Girdle view of single frustule × 1,000

FIG. 7—Synedra affinis, var. fasciculata.—Girdle view of single frustule × 1,000.

FIG. 8.—Sphærozosma pulchrum.

FIG. 9.—Desmidium Aptogonum.

FIG. 10.—Euastrum inermius, var. burmense.—Single cell-front view.

# INDEX.

MGIPC—L—III-7-7—28-8-37—1,000.



Surface vegetation of a choked up tank in the Royal Botanic Garden, Calcutta, showing group of Nymphaea rubra in the foreground, amphibious species of Herpestis Monniera and the grass Panicum muticum in the background. Pistia, Lemna, Salvinia and Azolla form smaller members in between the interstices of the latter species. (Photo by K. Biswas.)



A choked up tank in the Royal Botanic Garden The surface vegetation of a dense growth of the grass Panicum flavescens is being replaced by mass of Eichornia speciosa (Photo by K Biswas)



A shallow lake in South Burma (Tenasserim) showing floating mass of algæ (Trichoplankton) in the foreground (Photo by K Biswas)



Portion of choked up lake in the Royal Botanic Garden Calcutta, by rooted aquatics (Pleuston) In the foreground is seen pure society of (Nelumbium speciosum)—Red Lotus (Photo by K Biswas)

Portion of choked up lake in the Royal Botanic Garden, Calcutta, by rooted aquatics (Pleuston) In the foreground is seen pure society of (Nelumbium speciosum)—Red Lotus (Photo by K. Biswas)



... floating ... of vegetation ... O ... Triab ... oa ... d ... F ... full ... O ... corner is seen ... (Photo by K. B ...)

PHOTO VI.



Victoria regia in flower cultivated in the Eden Garden, Calcutta (Photo received from Mr M Jones Asstt Curator, Government Gardens, Calcutta)

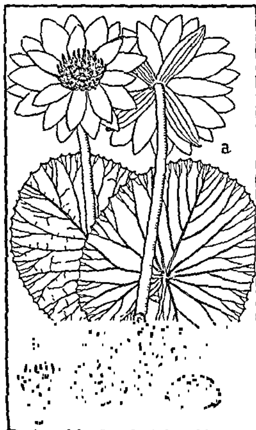



FIG. 1. NYMPHAEA RUBRA.

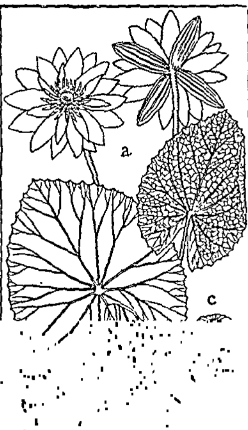



FIG. 2. NYMPHAEA LOTUS.

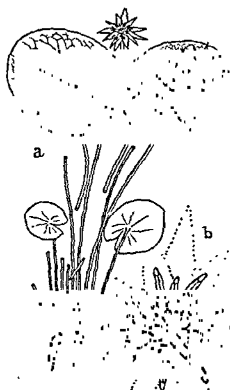



FIG. 3. NYMPHAEA STELLATA.

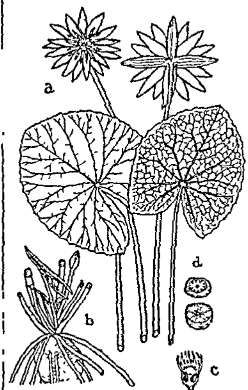



FIG. 4. NYMPHAEA CYANEA.

Fig 1 Euryale ferox

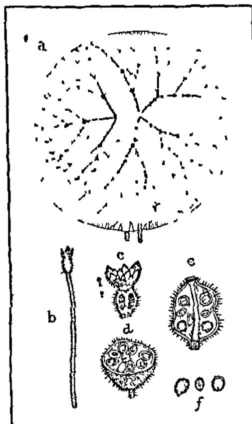
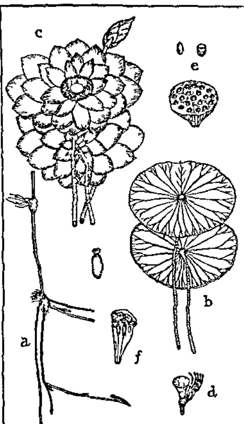



Fig 2 Nelumbium speciosum var rubra



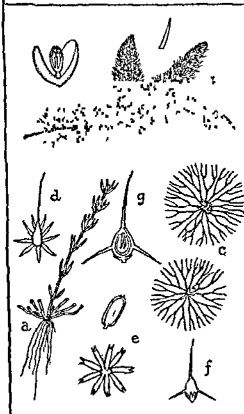




Fig 3 Ceratophyllum demersum

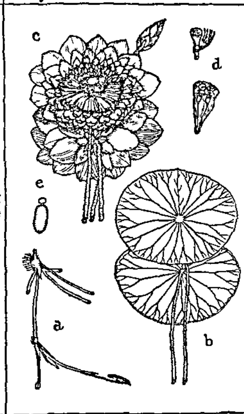



Fig 4 Nelumbium speciosum

Fig 1 Trapa bispinosa

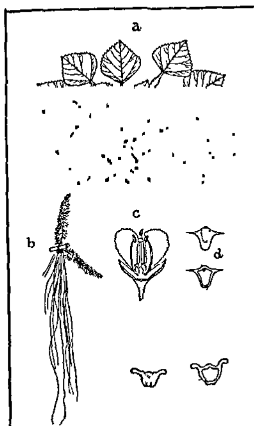



Fig 2 Lagarosiphon roxburghii

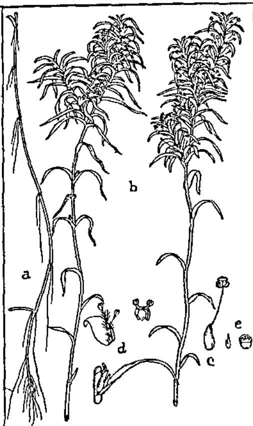






Fig 3 Leersia hexandra

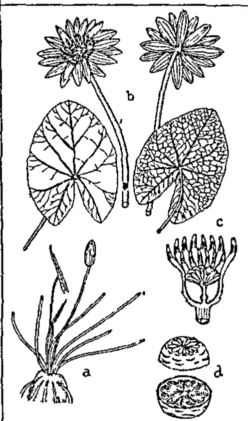
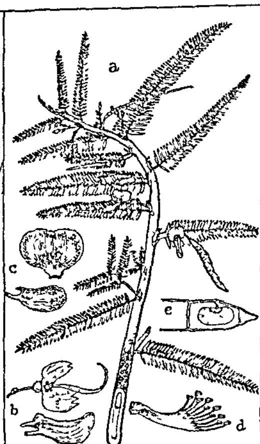


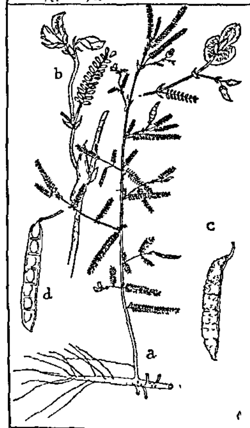

Fig 4, Nymphaea esculenta

Fig. 1. Oryza sativa.




Fig. 2. Aeschynomene aspera.



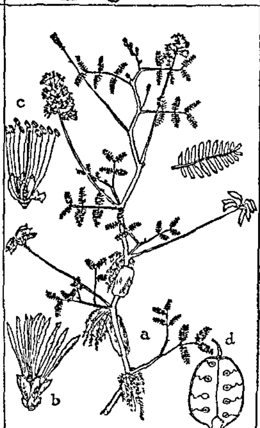
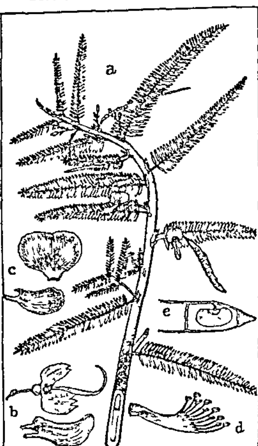
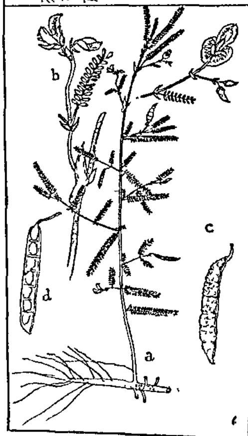




Fig. 3. Aeschynomene

Fig. 1. Oryza sativa.

Fig. 2. Aeschynomene aspera.



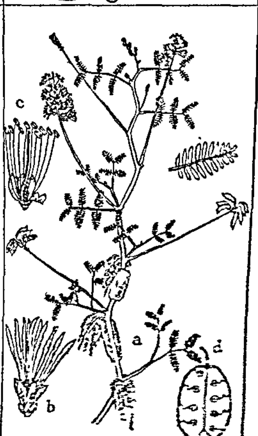




Fig. 3. Aeschynomene

Fig. 1. Ipomoea aquatica.

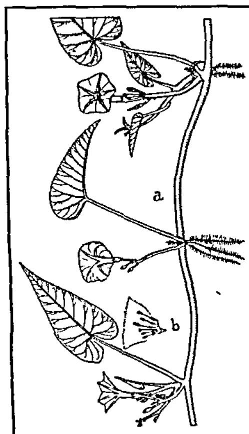
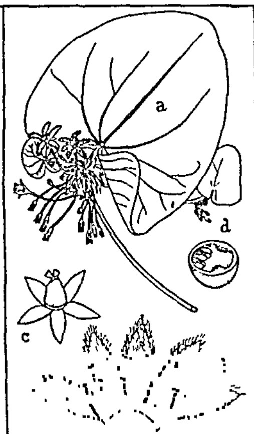



Fig. 2. Limnanthemum indicum.



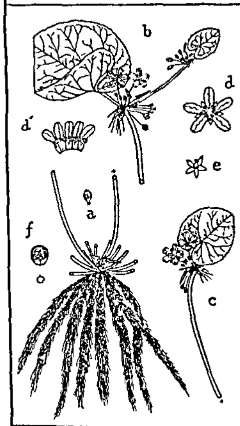




Fig. 3. Limnanthemum cristatum.

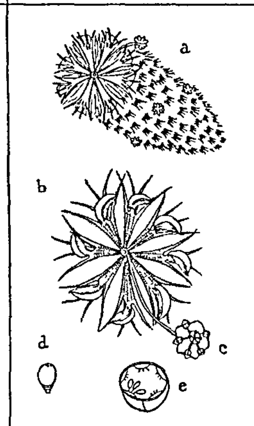



Fig. 4. Aldrovanda vesiculosa.

PLATE VI.

FIG. 1. OENANTHE BENGHALENSIS.

FIG. 2. ENHYDRA FLUCTUANS.




FIG. 3. HYDROLEA ZEYLANICA.

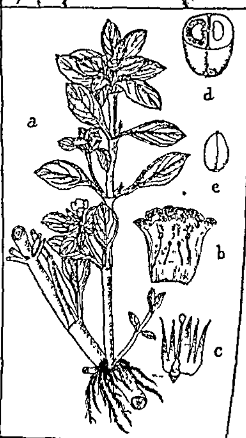



FIG. 4. LIMNOPHILA ROXBURGHII.

Fig 1 Limnophila conferta

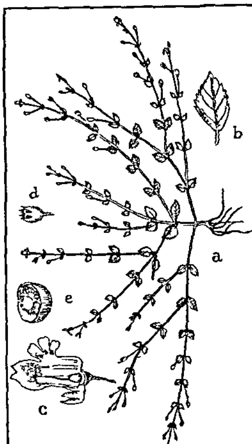



Fig. 2 Limnophila hypericifolia



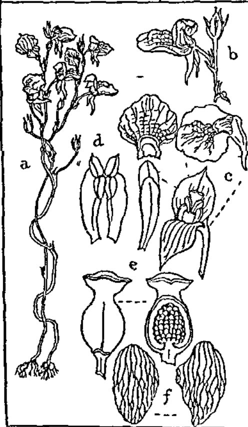




Fig 3 Utricularia reticulata

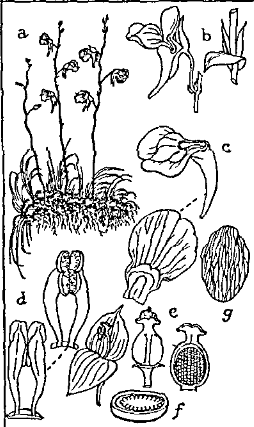



Fig 4 Utricularia wallichiana

FIG 1 (B) MYRIOPHYLLUM INDICUM

FIG 1 (A) MYRIOPHYLLUM TUBERCULATUM  FIG 2 LIMNOPHILA HETEROPHYLLA

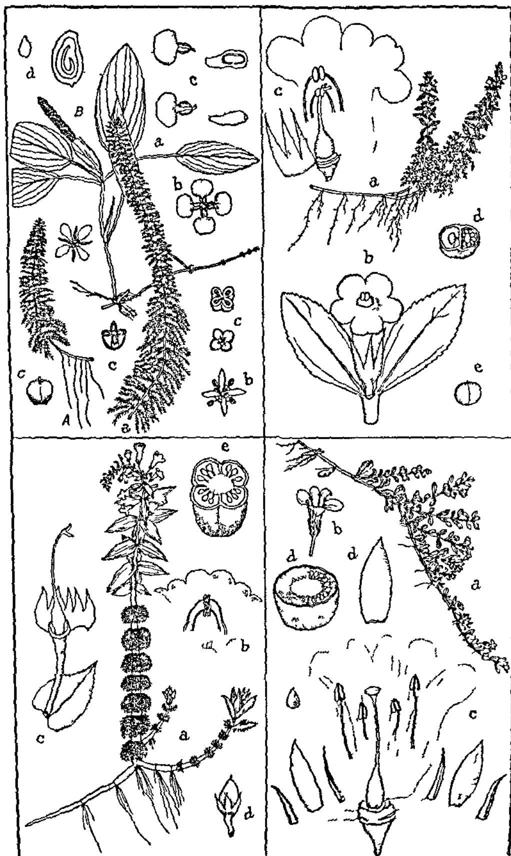



FIG 3 LIMNOPHILA RACEMOSA  FIG 4 HERPESTIS MONNIERA

Fig 1 Dopatrium nudicaule

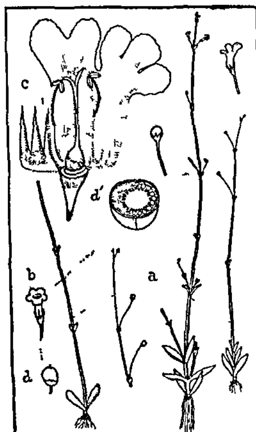
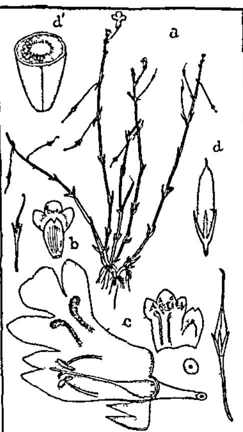



Fig 2 Dopatrium lobelioides



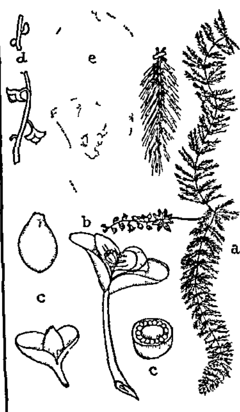




Fig 3 Utricularia stellaris

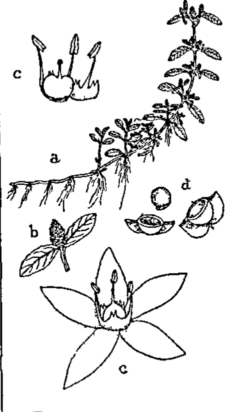



Fig 4 Alternanthera sessilis

PLATE X.

Fig. 1. Utricularia racemosa.




Fig. 2. Hygrophila spinosa.

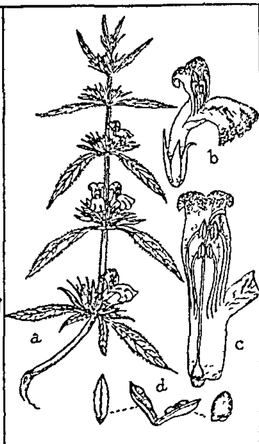






Fig. 3. Acanthus ilicifolius.




Fig. 4. [illegible]

Fig 1 Ranunculus sceleratus

Fig 2 Bythophyton indicum



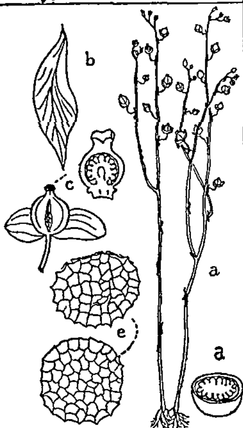




Fig 3 Podostemon wallichii

Fig 4 Utricularia bifida




Fig 1 Polygonum glabrum

Fig 2 Polygonum lanigerum

olygonum barbatum

Fig 1 Hydrocharis morsus-ranae.

Fig 2 Alpinia allughas




Fig 3 Boottia cordata

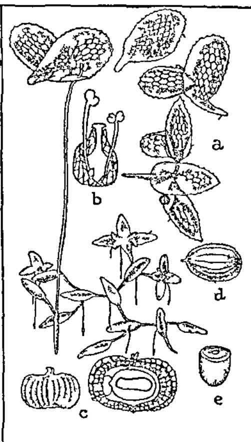


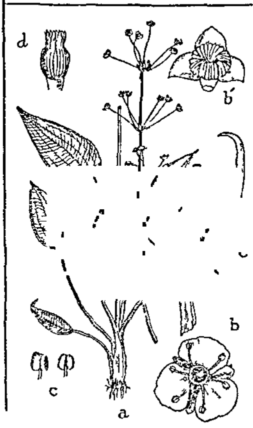

Fig 4 Aneilema hamiltonianum

FIG 1 LEMNA POLYRRHIZA

FIG 2 LEMNA TRISULCA



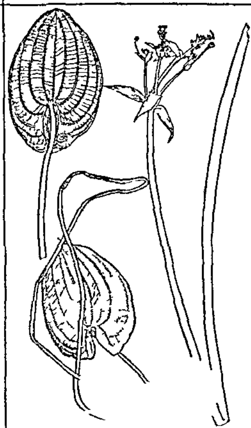



FIG 3 ALISMA PLANTAGO

FIG 4 AL

Fig 1 Wolffia arrhiza

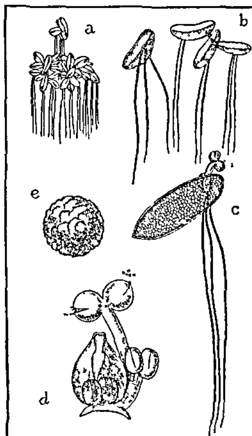
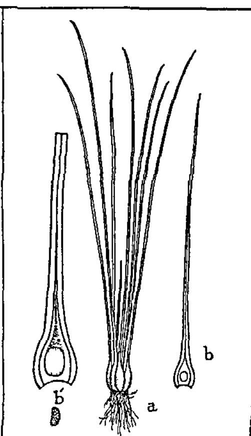



Fig 2 Isoetes coromandeliana.



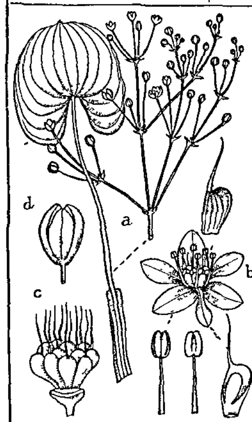




Fig 3 Alisma reniforme

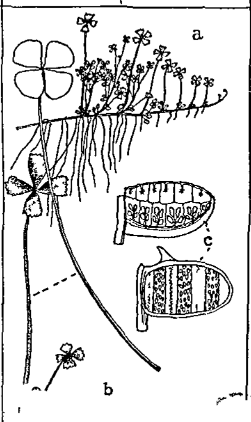
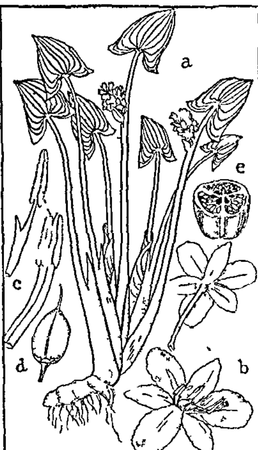



Fig 4 Marsilea qua

Fig 1 Cardanthera triflora




Fig 2 Monochoria hastaefolia



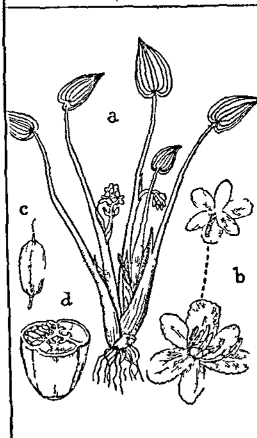




Fig 3 Monochoria vaginalis

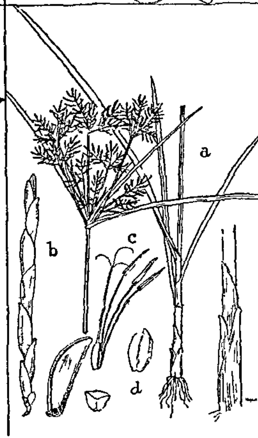



Fig 4 Cyperus

Fig. 1. Pistia stratiotes.

Fig. 2. Limnophyton obtusifolium.

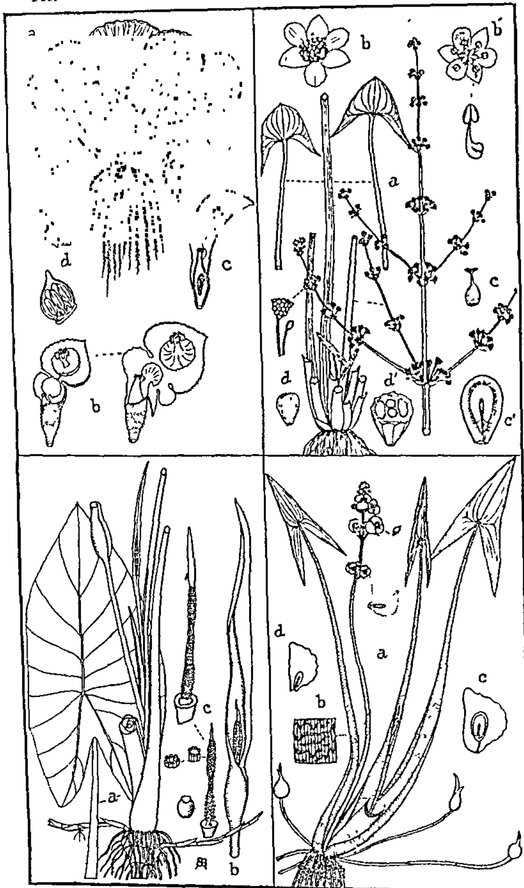



Fig. 3 Colocasia antiquorum

Fig. 4. S

Fig. 1. Suaeda maritima.

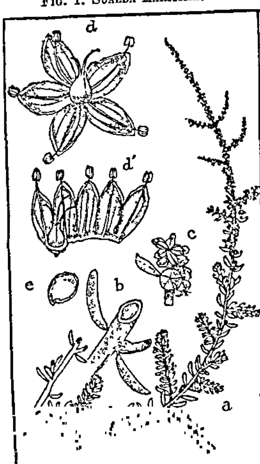
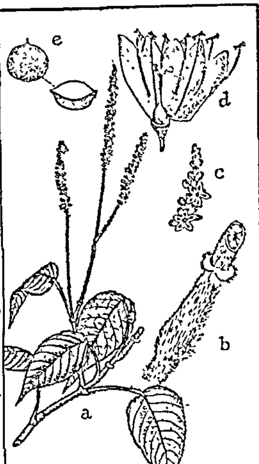



Fig. 2. Polygonum orientale.



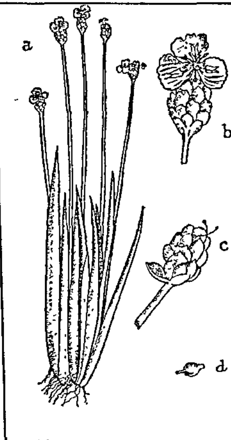




Fig. 3. Xyris indica.




Fig. 4. Nipa fruticans.

Fig. 1 (b). Utricularia flexuosa.
Fig. 1. (a). Utricularia exoleta. Fig. 2. Cryptocoryne retrospiralis.

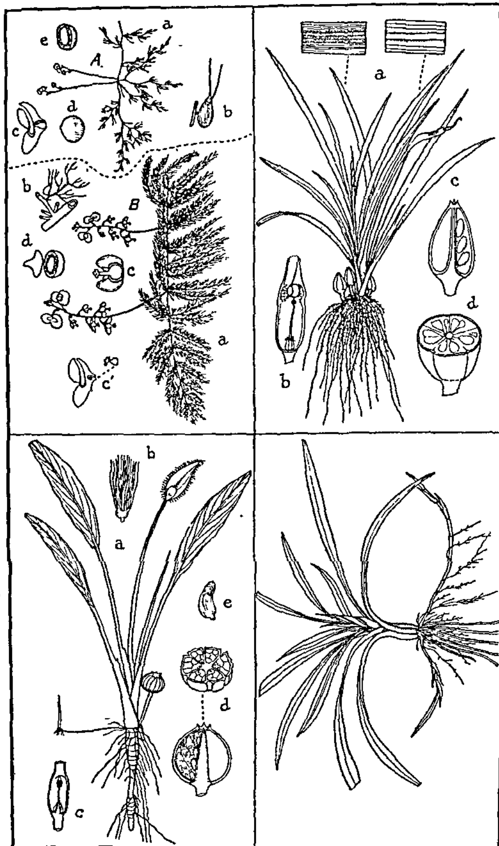



Fig. 3. Cryptocoryne ciliata. Fig. 4. Cryptocoryne

Fig. 1 Commelina salicifolia Fig. 2 Typha elephantina

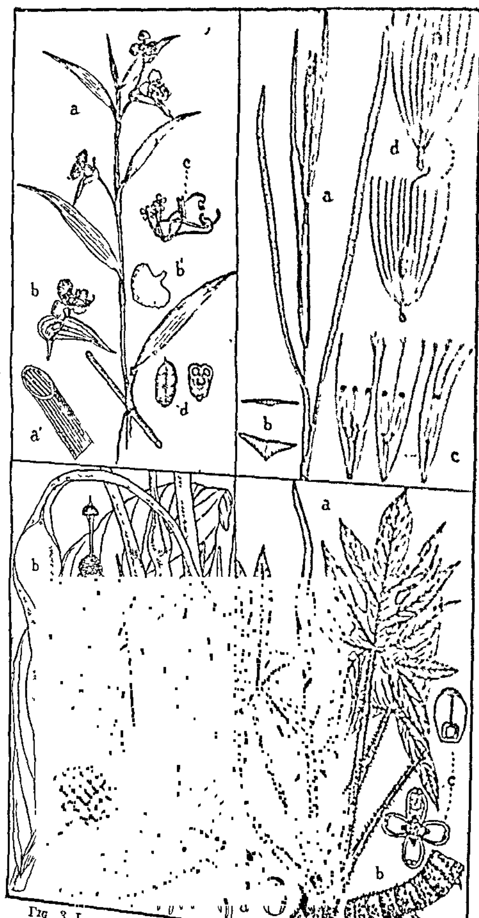
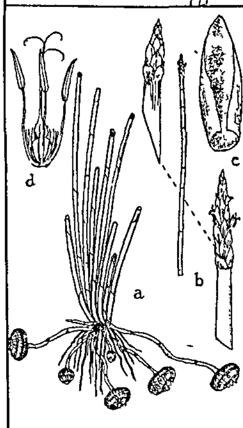


Fig 1 Eleocharis fistulosa

Fig 2 Eleocharis spiralis



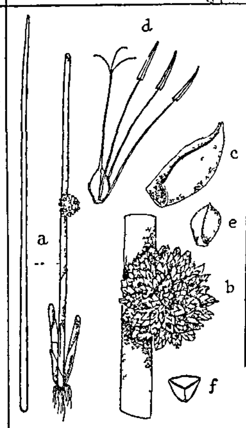




Fig 3 Eleocharis tuberosa

Fig 4 Scirpus

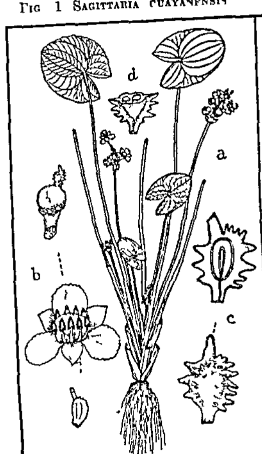



Fig 1 Sagittaria guayanensis




Fig 2 Aponogeton crispum

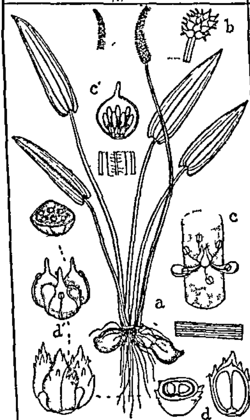



Fig 3 Aponogeton monostachyon

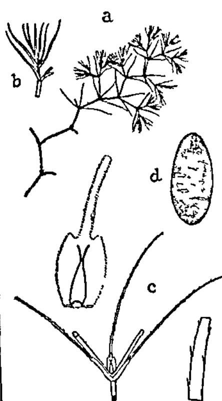



Fig 4 Naias minor

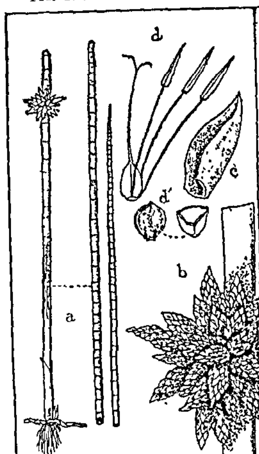



Fig. 1. Scirpus articulatus.

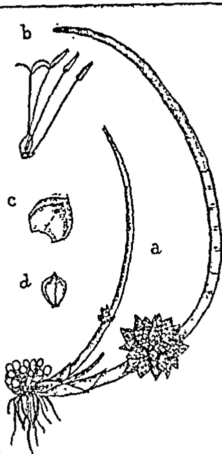



Fig. 2. Scirpus articulatus.

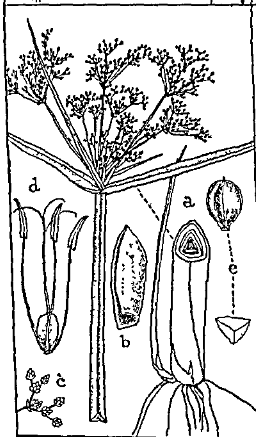



Fig. 3. Scirpus Grossus.




Fig. 4. Serpicula indica.

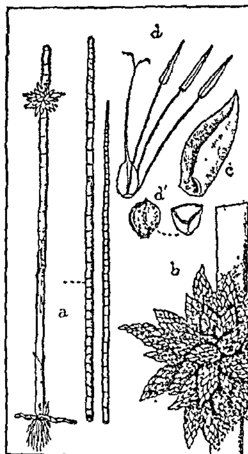



FIG 1. SCIRPUS ARTICULATUS

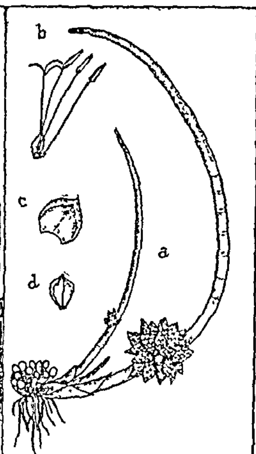



FIG 2 SCIRPUS ARTICULATUS.

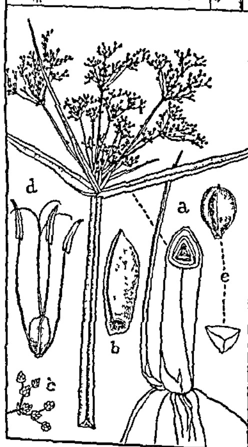



FIG 3. SCIRPUS GROSSUS.

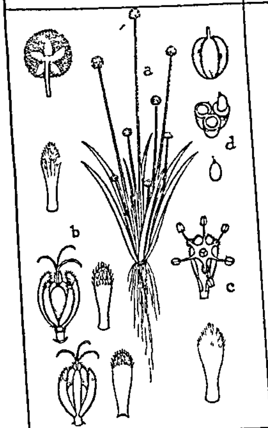



FIG 4. S

PLATE XXV

Fig 1 Eriocaulon sieboldianum

Fig 2 Paspalum scrobiculatum



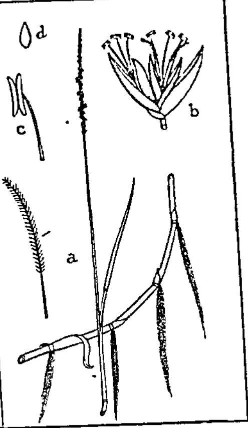




Fig 3 Eriocaulon quinquangulare

Fig 4 Panicum indicum

FIG. 1. CYPERUS TEGETUM. FIG. 2. CYPERUS PROCERUS.

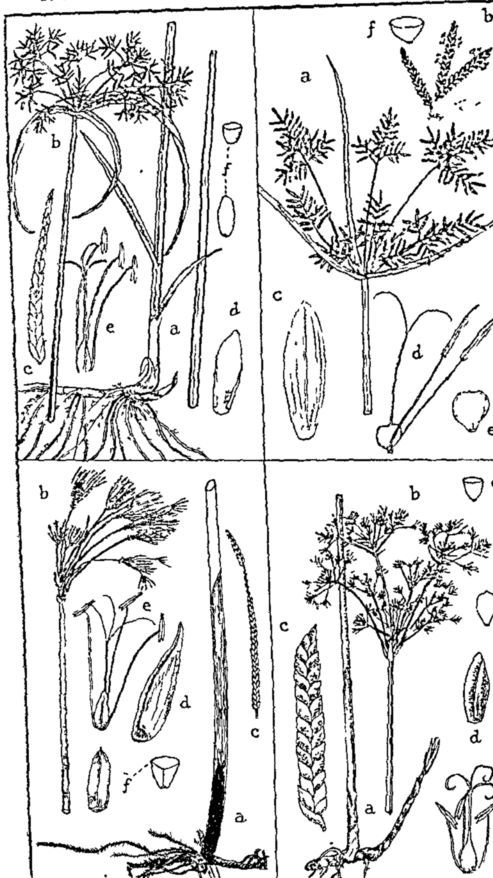


Fig 1. Cyperus tegetum. Fig 2 Cyperus procerus.

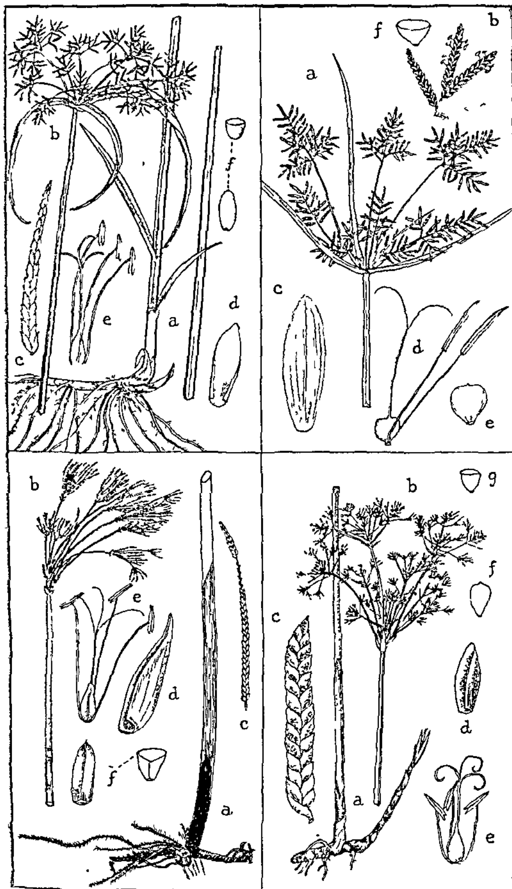
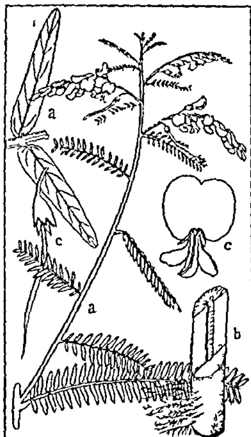


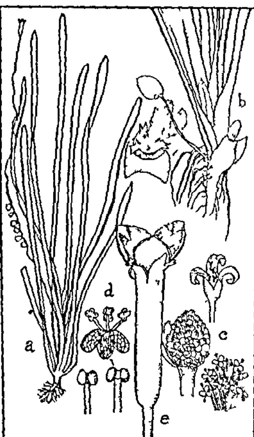
FIG. 3 (A) ELEOCH...RIS SPIRALIS.

FIG 4. S

FIG 1 SESBANIA PALUDOSA

FIG 2 VALLISNERIA SPIRALIS







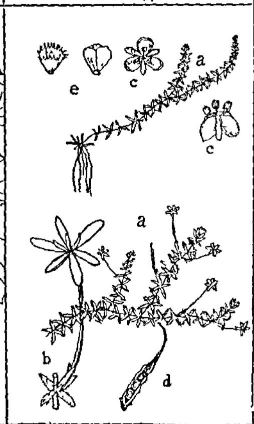



FIG 3 TRAPA NATANS

FIG 4 HYDRILLA VERTICILLATA

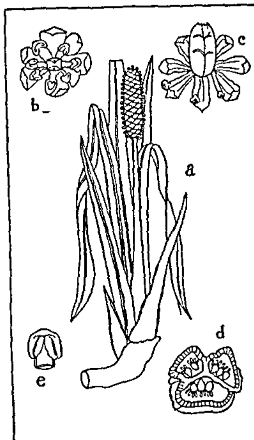



FIG. 1. ACORUS CALAMUS

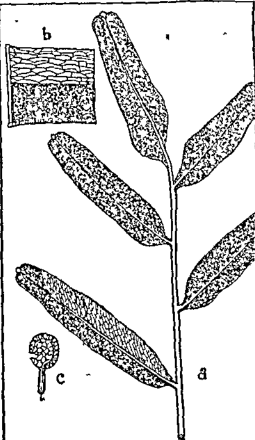



FIG. 2 ACROSTICHUM AUREUM

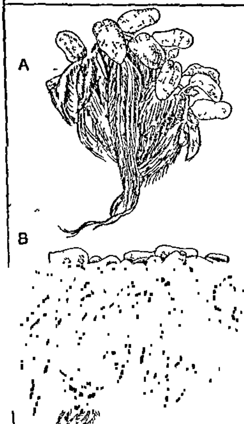



FIG 3 (A) SALVINIA NATANS.
(B) SALVINIA CUCULLATA

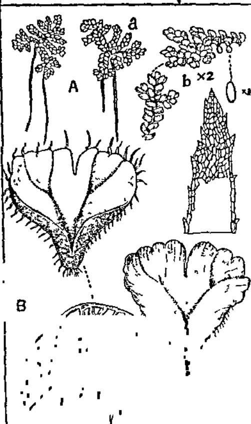
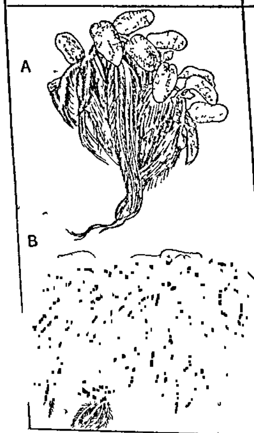



FIG 4 (A) AZOLLA PINNATA
(B) RICCIOCARPUS NATANS

Fig. 1. Acorus calamus

Fig. 2 Acrostichum aureum.



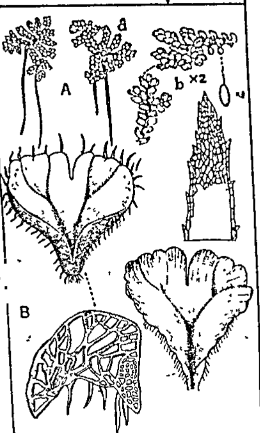
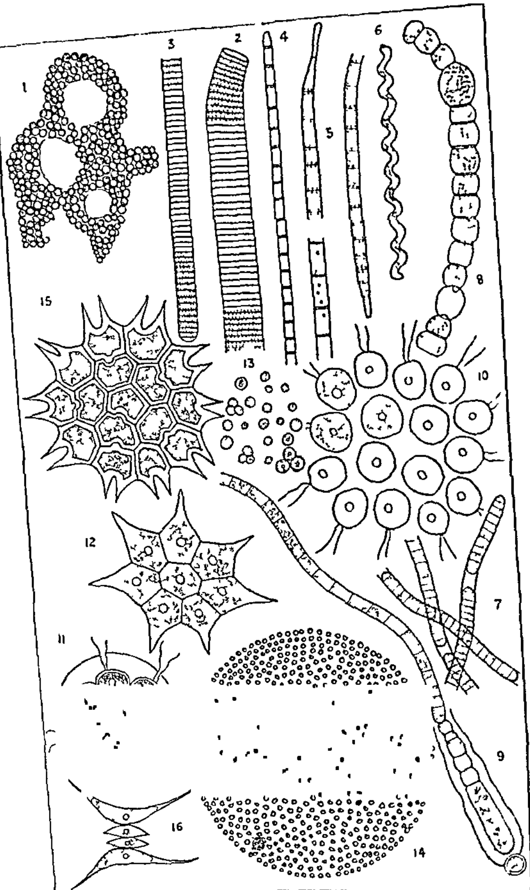
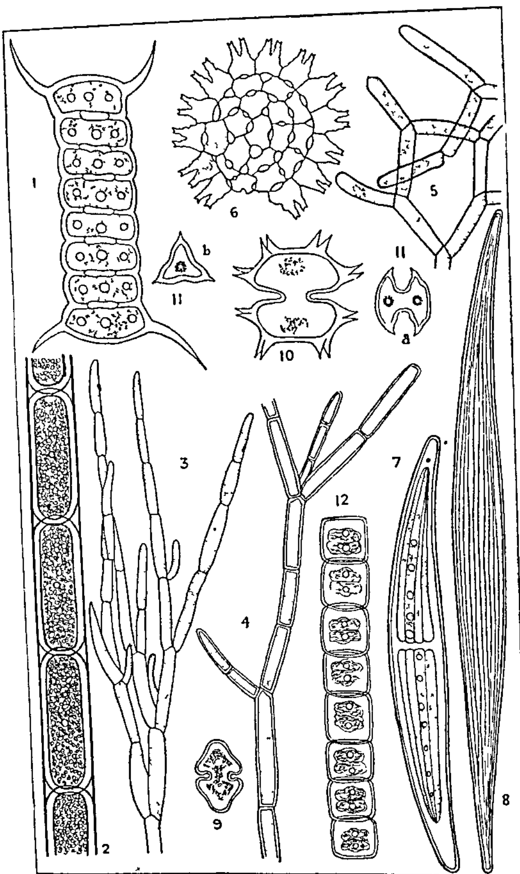




Fig 3 (A) Salvinia natans
(B) Salvinia cucullata

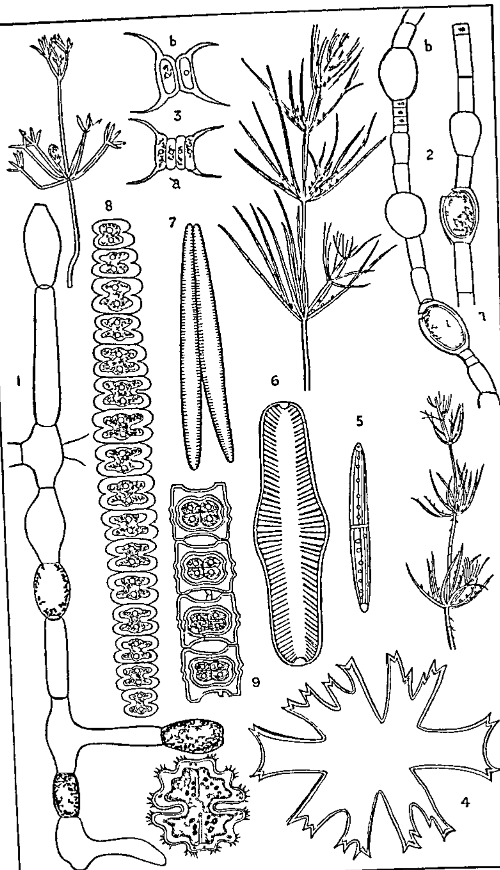
Fig 4 (A) Azolla pinnata
(B) B




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